North Carolina State Library
Raleigh
N. C.
Doc.

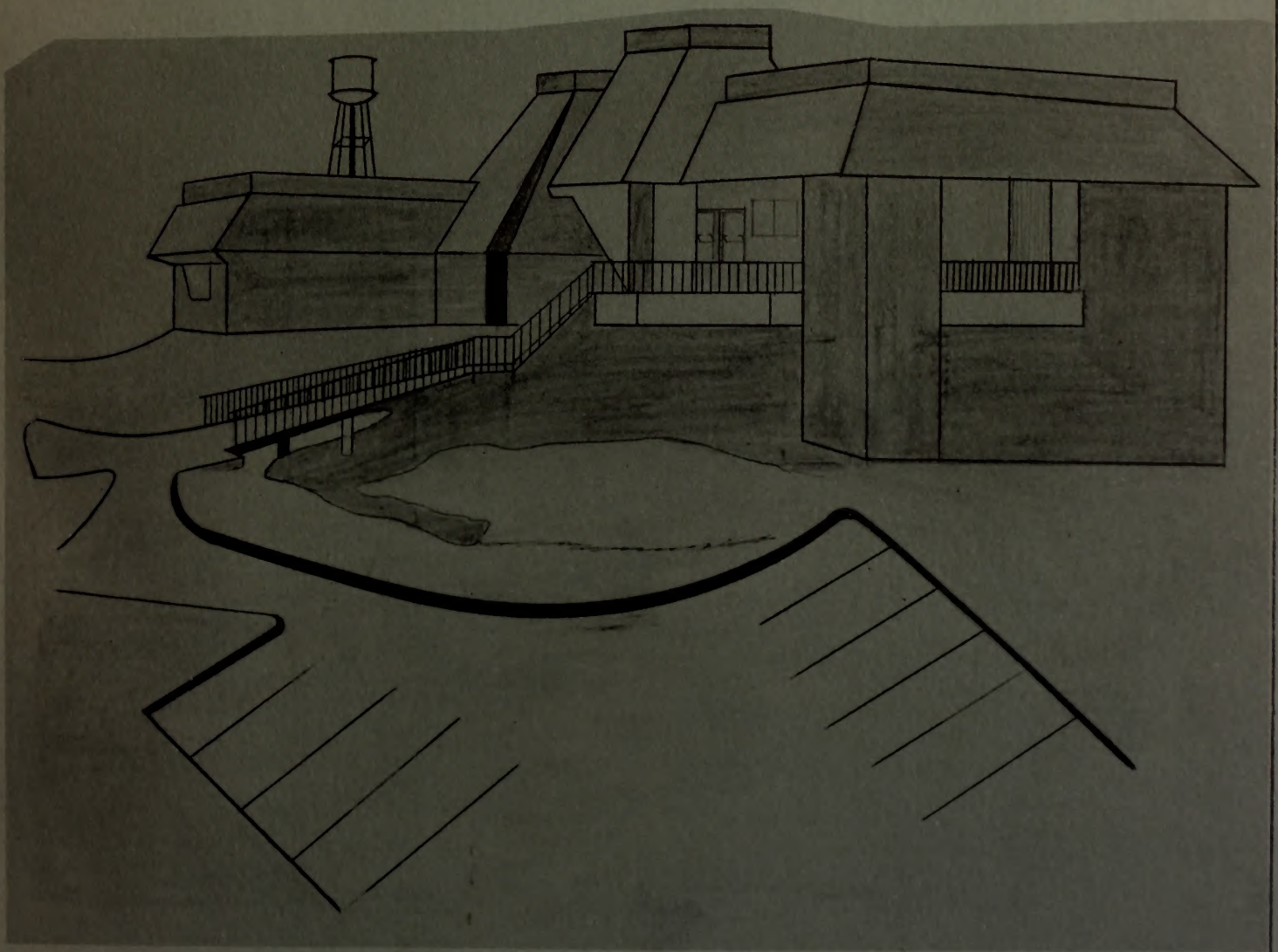
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

K4
11/2:A64
c. 2

OCT 21 1982

APEX

THOROUGHFARE PLAN



DIVISION OF HIGHWAYS

THOROUGHFARE PLAN

for

Apex, North Carolina

Prepared by the:

Thoroughfare Planning Unit
Planning and Research Branch
Division of Highways
N. C. Department of Transportation

In cooperation with:

The Town of Apex
The Federal Highway Administration
U. S. Department of Transportation

January 1982

Persons Responsible for this Report:

Planning and Research Manager	T. L. Waters
Thoroughfare Planning Engineer:	M. R. Poole
Project Planners:	W. I. Beddingfield
	J. L. Whitaker, Jr.
Engineering Technician:	J. M. Spencer, Jr.
Typist:	JoAn Crenshaw

STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION
RALEIGH 27611

JAMES B. HUNT, JR.
GOVERNOR

WILLIAM R. ROBERSON, JR.
SECRETARY

DIVISION OF HIGHWAYS

July 14, 1982

The Honorable Larry Jordan
Mayor of Apex
Members of the Town Council
Members of the Planning Board
Town of Apex
Apex, North Carolina

Gentlemen:

We are pleased to submit herewith the Apex Thoroughfare Plan Report giving a description of the plan and describing the inventory, analysis, and other supporting data. This Thoroughfare Plan was developed as a guide for solving the existing and anticipated traffic problems within the Apex Urban Area. The basis for the plan was a series of traffic, economic, population, and land use studies of the area.

It is emphasized that the proposed thoroughfare system is a balanced network and is completely dependent, one part upon the other. A high degree of cooperation and coordination must prevail as the Thoroughfare Plan is implemented.

We wish to express our sincere appreciation for the fine cooperation extended to us during the preparation of this report.

Cordially yours,

Billy Rose

Billy Rose
State Highway Administrator

BR/jc

TABLE OF CONTENTS

CHAPTER		Page
I.	INTRODUCTION	1
II.	THOROUGHFARE PLANNING PRINCIPLES	3
	Operational Efficiency	4
	System Efficiency	5
	Functional Classification	5
	Idealized Major Thoroughfare System	6
	Application of Thoroughfare Planning Principles	8
III.	EXISTING AND PROJECTED CONDITIONS	11
	Apex Past, Present, and Future	11
	Population	13
	Economy and Employment	14
	Land Use	19
	Travel	20
IV.	DEVELOPMENT AND ANALYSIS OF THOROUGHFARE PLAN	25
	Existing System	25
	Capacity Deficiency Analysis	25
	Traffic Accidents	31
	Do-Nothing Alternative	32
	Goals and Objectives	33
	Alternate A - Existing Major Street System	36
	Alternate B - Existing Thoroughfare Plan	36
	Alternate C	37
	Alternate D - Recommended Thoroughfare Plan	37
	Evaluation of Alternate Plans Relative to Environmental Impacts	37
	Physical Environmental Considerations	37
	Air Quality	38
	Water Quality and Conservation	38
	Soil and Geology	40
	Wildlife and Vegetations	41
	Social Environmental Considerations	
	Noise Levels	41
	Churches and Educational Facilities	42
	Parks and Recreational Facilities	42
	Natural and Historic Landmarks	42
	Public Health and Safety	43
	National Defense	43
	Aesthetics	43

Economic Environmental Considerations 51
Business 51
Employment and Income 51
Land Development Patterns 51
Public Utilities 52

V. RECOMENDATIONS 57

The Proposed Thoroughfare Plan 57
Radial and Crosstown Streets 57
Loop System 57
Bypass 58
Minor Thoroughfares 58
Design Requirements 58
Construction Priorities and Cost Estimates. 58
First Priority 59
Second Priority. 59
Third Priority 63
Fourth Priority. 63
Traffic Operations 64
Transit 65
Parking 65
Bicycles. 66

VI. IMPLEMENTATION 69

State Municipal Adoption of The Thoroughfare Plan 69
Subdivision Control 69
Official Street Map 70
Zoning 70
Urban Renewal 70
Capitol Improvements Program 71

APPENDIX A

Travel Forecast Models A-1

APPENDIX B

Existing and Future Street Data B-1

APPENDIX C

Recommended Definitions and Design Standards for Subdivision Ordinances C-1

LIST OF FIGURES

		Page
1.	Idealized T. P.	6
2.	Geographic Location	12
3.	Study Area Population Projections	15
4.	Internal Zone Map	17
5.	Apex Land Use	21
6.	Existing Street System	27
7.	Level of Service	30
8.	Existing Thoroughfare Plan	45
9.	Alternate Plan C	47
10.	Recommended Thoroughfare Plan (Alt. D)	49
11.	Typical Thoroughfare Cross Sections	53
12.	Proposed Construction Priorities	61

LIST OF TABLES

		Page
1.	Population Totals and Trends for the Apex Area .	14
2.	1978 Planning Area Employment by SIC Code . . .	19
3.	Travel Data Summary	24
4.	Accident Locations	32
5.	Goals and Objectives	34
6.	Estimated Average Motor Vehicle Pollutant Emissions	39
7.	Construction Priorities and Cost Estimates . . .	60

APPENIX A

		Page
1.	Total Income of Dwelling Units	A-1
2.	Trip Generation Rates by Median Income and Person/Dwelling Unit	A-2
3.	Study Area Constants	A-2
4.	1978 Employment Data by Zone and Type	A-4
5.	1978 Dwelling Unit, Population, and Trip Data. .	A-7
6.	Multiple Regression Statistical Data	A-9
7.	Trip Length Frequency Curves	A-10
8.	Screenline Accuracy Checks	A-10
9.	2000 Employment Data by Zone	A-12
10.	2000 Trip Length Frequency Curves.	A-13
11.	2000 Dwelling Unit, Population, and Trip Data. .	A-15
12.	Historical and Projected Average Daily Traffic .	A-17
13.	2005 Employment Data by Zone	A-20
14.	2005 Dwelling Unit, Population, and Trip Data. .	A-21

APPENDIX B

1.	Street Data	B-1

I. INTRODUCTION

This urban community, as any urban community, relies heavily upon a useful highway system for the efficient and economical movement of persons and goods. It is necessary that such a system not only meet existing travel demands, but also that it keep pace with the development of the urban area. This report will set forth a system of thoroughfares to serve the anticipated traffic and land development needs of the Apex area for the next twenty years.

The system of thoroughfares proposed was developed following the basic principles of thoroughfare planning as described in Chapter II of this report. Major thoroughfares were located based upon detailed analyses of existing and anticipated travel demands, existing streets, existing land development, existing and anticipated land uses, and topographic conditions. The plan advocates those improvements which are felt to be essential for proper traffic circulation within the current planning period (1978-2005).

Some of the proposed improvements will be the responsibility of the Division of Highways, while the municipality will be responsible for other improvements. With the different governmental units involved in developing the thoroughfare system, coordination is important. The plan should be formally adopted by both the local governing body and the Board of Transportation to serve as a mutual, official guide in the development of the thoroughfare system.

In order for the plan to be effective, it is essential that legal controls, such as municipal subdivision regulations be used to protect the rights-of-way necessary for the improvements which will be ultimately required.

It should be emphasized that the Plan is based on the anticipated growth of the urban area as indicated by current trends. If actual growth rates and patterns differ from those anticipated, it may become desirable to accelerate or retard the development of the system or to make adjustments in the Plan commensurate with variations in the anticipated development.

The Town of Apex is operating under a thoroughfare plan adopted in December, 1967. Since adoption of the previous plan, US 1 Bypass southwest of NC 55 has been completed. The addition of this bypass has aided the flow of traffic through the central part of the state.

The purpose of the present study is to re-examine the present and future transportation needs of Apex in light of more up-to-date data, and to revise the 1967 thoroughfare plan as appropriate.

This report documents the effort that went into revising the 1967 plan, including the analyses of population, employment, land use, the development of mathematical models of travel demand, the design and evaluation of several alternative street networks, and the recommendation of one of these systems as the best. The report also includes recommended cross sections for thoroughfares, suggested priorities for thoroughfare projects, estimated costs of the projects, and possible means of implementing the plan.

II. THOROUGHFARE PLANNING PRINCIPLES

Typically, the urban street system occupies 25 to 30 percent of the total developed land in an urban area. Since the system is permanent and expensive to build and maintain, much care and foresight are needed in its development. Thoroughfare planning is the process used by public officials to assure the development of the most appropriate street system to meet existing and future travel desires within the urban area.

The primary aim of a thoroughfare plan is to guide the development of the urban street system in a manner consistent with changing traffic demands. Through proper planning for street development, many costly errors and much needless expense can be averted. A thoroughfare plan will enable street improvements to be made as traffic demands increase, and only such improvements necessary to meet these demands need be made. By developing the urban street system to keep pace with increasing traffic demands, a maximum utilization of the system can be attained, thereby requiring a minimum amount of land for street purposes. In addition to providing for traffic needs, the thoroughfare plan should embody those details of good urban planning necessary to present a pleasing and efficient urban community. The location of present and future population, commercial, and industrial enterprises, affects major street and highway locations. Conversely, the location of major streets and highways within the urban area will influence the urban development pattern.

Other objectives of a thoroughfare plan include:

- To provide for the orderly development of an adequate major street system as land development occurs;
- To reduce travel and transportation costs;
- To reduce the cost of major street improvements to the public through the coordination of the street system with private action;
- To enable private interests to plan their actions, improvements, and development with full knowledge of public intent;
- To minimize disruption and displacement of people and businesses through long range advanced planning for major street improvements;
- To reduce environmental impacts such as air pollution, resulting from transportation;

- To increase travel safety.

Thoroughfare planning objectives are achieved through both (1) improving the operational efficiency of thoroughfares and (2) improving the system efficiency through system coordination and layout.

Operational Efficiency

A street's operational efficiency is improved by increasing the capability of the street to carry vehicular traffic and people. In terms of vehicular traffic, a street's capacity is defined as the maximum number of vehicles which can pass a given point on a roadway during a given time period under prevailing roadway and traffic conditions. Capacity is affected by the physical features of the roadway, nature of traffic and weather.

Physical ways to improve vehicular capacity include street widening, intersection improvements, improving vertical and horizontal alignment, and eliminating roadside obstacles. For example, widening a street from two to four travel lanes more than doubles the capacity of the street by providing additional maneuverability for traffic. Impedances to traffic flow caused by slow moving or turning vehicles and adverse effects of horizontal and vertical alignments are thus reduced.

Operational ways to improve street capacity include:

Control of access - A roadway with complete access control can often carry three times the traffic handled by a non-controlled access street with identical lane width and number.

Parking removal - Increases capacity by providing additional street width for traffic flow and reducing friction to flow caused by parking and unparking vehicles.

One-Way Operation - The capacity of a street can sometimes be increased 20-50%, depending upon turning movements and overall street width, by initiating one-way traffic operations. One-way streets can also improve traffic flow by decreasing potential traffic conflicts and simplifying traffic signal coordination.

Reversible lanes - Reversible traffic lanes may be used to increase street capacity in situations where heavy directional flows occur during peak periods.

Signal phasing and coordination - Uncoordinated signals and poor signal phasing restrict traffic flow by creating excessive stop-and-go operation.

Altering travel demand is a third way to improve the efficiency of existing streets. Travel demand can be reduced or altered in the following ways:

- Encourage people to form carpools and vanpools for journeys to work and other trip purposes. This reduces the number of vehicles on the roadway and raises the people-carrying capability of the street system.

- Encourage the use of transit and the bicycle mode.

- Encourage industry, business, and institutions to stagger work hours or establish variable work hours for employees. This will reduce travel demand in peak periods and spread peak travel over a longer time period.

- Plan and encourage land use development or redevelopment in a more travel-efficient manner.

System Efficiency

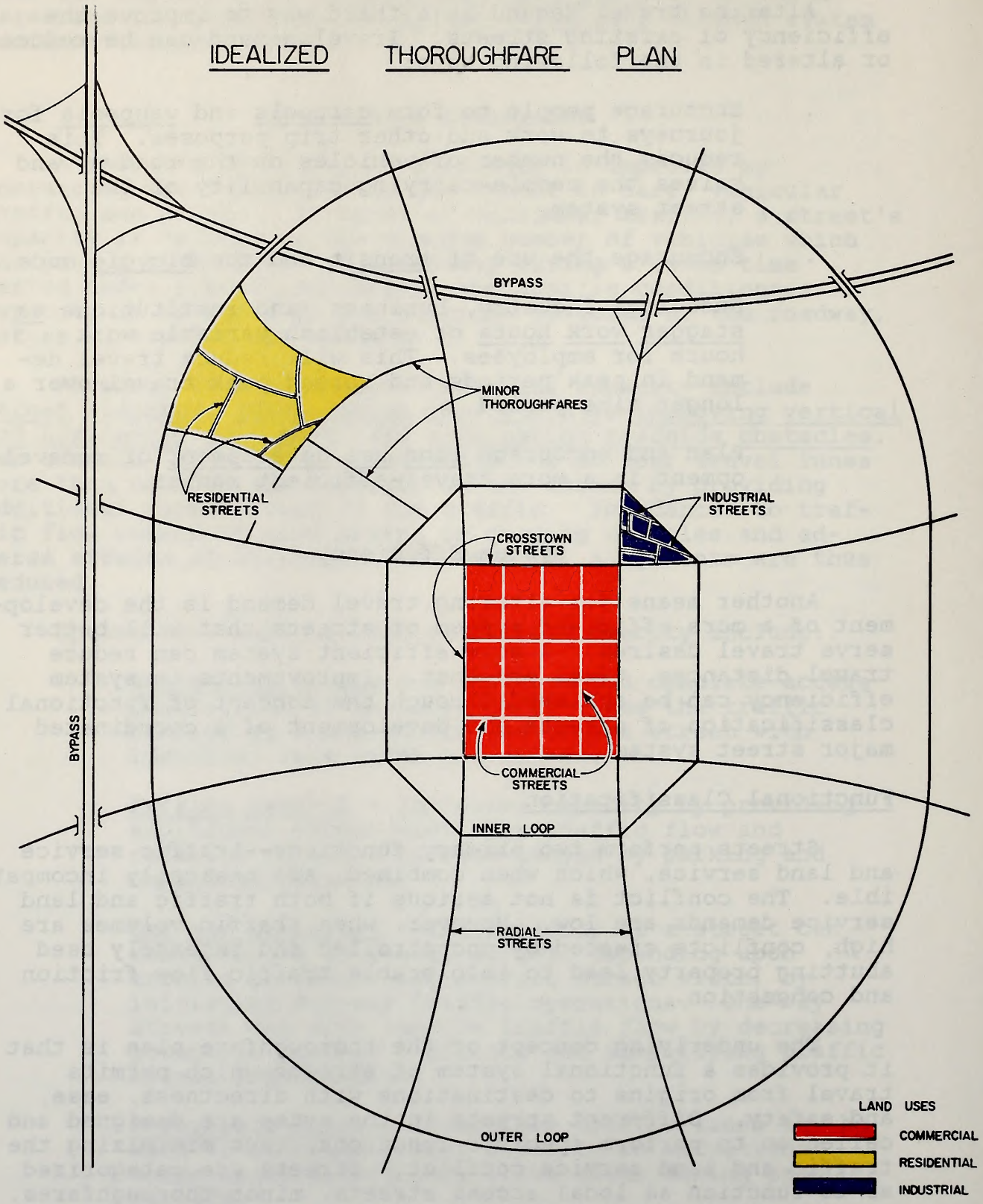
Another means for altering travel demand is the development of a more efficient system of streets that will better serve travel desires. A more efficient system can reduce travel distances, time, and cost. Improvements in system efficiency can be achieved through the concept of functional classification of streets and development of a coordinated major street system.

Functional Classification

Streets perform two primary functions--traffic service and land service, which when combined, are basically incompatible. The conflict is not serious if both traffic and land service demands are low. However, when traffic volumes are high, conflicts created by uncontrolled and intensely used abutting property lead to intolerable traffic flow friction and congestion.

The underlying concept of the thoroughfare plan is that it provides a functional system of streets which permits travel from origins to destinations with directness, ease, and safety. Different streets in the sytem are designed and called on to perform specific functions, thus minimizing the traffic and land service conflict. Streets are categorized as to function as local access streets, minor thoroughfares, or major thoroughfares (See Figure 1).

FIGURE I


IDEALIZED THOROUGHFARE PLAN
BYPASS
MINOR THOROUGHFARES
RESIDENTIAL STREETS
INDUSTRIAL STREETS
CROSSTOWN STREETS
BYPASS
COMMERCIAL STREETS
INNER LOOP
RADIAL STREETS
OUTER LOOP
LAND USES
COMMERCIAL
RESIDENTIAL
INDUSTRIAL

Local access streets provide access to abutting property. They are not intended to carry heavy volumes of traffic and should be located such that only traffic with origins and destinations on the streets would be served. Local streets may be further classified as either residential, commercial, and/or industrial depending upon the type of land use which they serve.

Minor thoroughfares are more important streets in the city system. They collect traffic from local access streets and carry it to the major thoroughfare system. They may in some instances supplement the major thoroughfare system by facilitating minor through traffic movements. A third function which may be performed is that of providing access to abutting property. They should be designed to serve limited areas so that their development as major thoroughfares will be prevented.

Major thoroughfares are the primary traffic arteries of the city. Their function is to move intra-city and inter-city traffic. The streets which comprise the major thoroughfare system may also serve abutting property; however, THEIR MAJOR FUNCTION IS TO CARRY TRAFFIC. They should not be bordered by uncontrolled strip development because such development significantly lowers the capacity of the thoroughfare to carry traffic and each driveway is a danger and an impediment to traffic flow. Major thoroughfares may range from a two-lane street carrying minor traffic volumes to major expressways with four or more traffic lanes. Parking normally should not be permitted on major thoroughfares.

Idealized Major Thoroughfare System

A coordinated system of major thoroughfares forms the basic framework of the urban street system. A major thoroughfare system which is most adaptable to desire lines of travel within an urban area and which permits movement between various areas of the city with maximum directness is the radial-loop system. This system consists of several functional elements-radial streets, crosstown streets, loop system streets, and bypasses (see Figure 1).

Radial streets provide for traffic movement between points located in the outskirts of the city and the central area. This is a major traffic movement in most cities, and the economic strength of the central business district depends upon the adequacy of this type of thoroughfare.

If all radial streets crossed in the central area, an intolerable congestion problem would result. To avoid this problem, it is very important to have a system of crosstown streets which form a loop around the central business district. This system allows traffic moving from origins on one side of the central area to destinations on the other to follow

the area's border and allows central area traffic to circle and then enter the area near a given destination. The effect of a good crosstown system is to free the central area of crosstown traffic, thus permitting the central area to function more adequately in its role as a pedestrian shopping area.

Loop system streets move traffic among suburban areas of the city. Although a loop may completely encircle the city, a typical trip may be from an origin near a radial thoroughfare to a destination near another radial thoroughfare. Loop streets do not necessarily carry heavy volumes of traffic, but they function to help relieve central areas. There may be one or more loops, depending on the size of the urban area, and they are generally spaced one-half mile to one mile apart, depending on the intensity of land use.

A bypass is designed to carry traffic through or around the urban area, thus providing relief to the city street system by removing from it traffic which has no desire to be in the city. Bypasses are usually designed to through highway standards, with control of access. Occasionally a bypass with low traffic volume can be designed to function as a portion of an urban loop. The general effect of bypasses is to expedite the movement of through traffic and to improve traffic conditions within the city. By freeing the local streets for use by shopping and home-to-work traffic, bypasses tend to increase the economic vitality of the local area.

Application of Thoroughfare Planning Principles

The concepts presented in the discussion of operational efficiency, system efficiency, functional classification, and the idealized major thoroughfare system are the conceptional tools available to the transportation planner in developing a thoroughfare plan. In actual practice, thoroughfare planning is done for established urban areas and is constrained by existing current expectations of future land use. Compromises must be made because of these and the many other factors that affect major street locations.

Throughout the thoroughfare planning process it is necessary from a practical viewpoint that certain basic principles be followed as closely as possible. These principles are:

1. The plan should be derived from a thorough knowledge of today's travel - its component parts, as well as the factors that contribute to it, limit it, and modify it.

2. Traffic demands must be sufficient to warrant the designation and development of each major street. The thoroughfare plan should be designed to accommodate a large portion of all major traffic movements on a relatively few streets.

3. The plan should conform to and encourage the land development plan of the area.

4. Certain considerations must be given to urban development beyond the current planning period. Particularly in outlying or sparsely-developed areas which have development potential, it is necessary to designate thoroughfares on a long-range planning basis to protect rights-of-way for future thoroughfare development.

5. While being consistent with the above principles and realistic in terms of travel trends, the plan must be economically feasible.

III. EXISTING AND PROJECTED CONDITIONS

Apex, Past, Present and Future

The Town of Apex was incorporated by an act of the General Assembly on February 23, 1873. The name Apex came from the fact that the town is located at the highest point on the former Chatham Railroad Company, which is now a part of the Seaboard Coast Line Railroad. The Chatham Railroad Company was for the purpose of effective communication between the North Carolina Railroad Company and the Coal fields of Chatham County. The early existence of Apex was justified not only by the transporting of coal but by lumber, pitch, turpentine, and tar industrial outputs as well.

In 1905, the tobacco industry established the first tobacco action market in Wake County with a warehouse located at the intersection of Hunter and Salem Streets. The tobacco industry was prominent in Apex until the middle 1920's when the market closed.

Since World War II, many industries have chosen to locate in the Apex area. These include manufacturers of cosmetics, swimwear, and wood products including plywood. These new industries and the convenient commuting distance to industries and governmental offices located in Raleigh have contributed to the rapid growth of Apex in recent years.

In a wider than regional sense, Apex enjoys a position near the northern anchor city of the Piedmont Industrial Crescent. This industrializing area extends from Raleigh westward through Durham, High Point, Winston-Salem, Greensboro and south through Charlotte into South Carolina. The location of Apex and Wake County in relation to the state and population centers is shown in Figure 2. Enhanced by efficient highway transportation, a pool of available labor, and an agreeable living climate, this industrializing trend has brought with it population increases for all of the cities along this crescent and an increase in the service and warehousing industries as well. Apex, because of its position near Raleigh, is subject to this effect.[1]

Between 1940 and 1960, Apex's population increased by 40%. Despite a lack of water and sewer facilities, Apex increased its' population by 63% during the decade of the 60's. Future growth in the Apex planning area will depend on how soon Apex obtains the necessary water and sewer extensions from Raleigh and Cary.

---

[1]Triangle J Council of Governments. Apex Policies Plan, 1976.

GEOGRAPHIC LOCATION

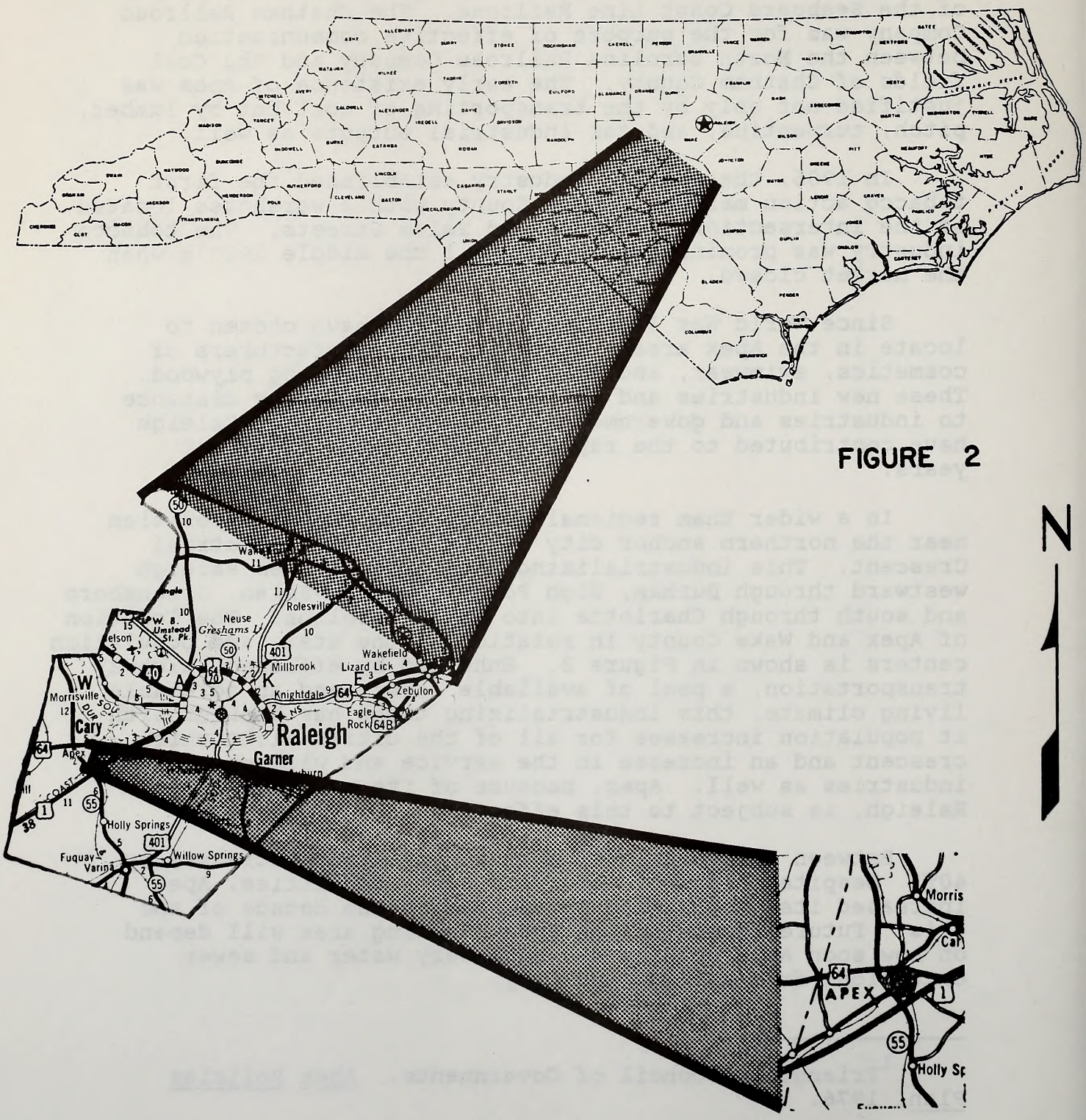


FIGURE 2

N

The median age of the Apex population is 28 years. This figure is higher than the median age for Wake County or for North Carolina as a whole, indicating that, within the Apex Town Limits, the population is generally older than elsewhere in the county and the State.

Employment in recent years reflects an increase in industrial and technical workers.

Industries that pay higher wages are expected to move into Apex during the next 20 years. This influx of new businesses is expected to increase Apex's median income and improve its' standard of living.

The Research Triangle Park is a significant area of employment for Apex residents and there is considerable travel to and from the Park by employees residing in Apex and adjacent areas. An increasing number of Apex residents have livilihoods either directly or indirectly connected with this Research center.

Population

Travel is directly related to population, and the volume of traffic on any section of roadway is closely related to the size and distribution of the population which it serves.

Table 1 shows population totals and trends for the Apex area. The population projections were made based on illustrations shown in Figure 3. Past trends were based on census data of the incorporated city limits. The transportation study area is similar to the Apex Planning Area Boundaries which included from one to two miles beyond the corporate limits. The planning area population was estimated by an actual dwelling unit count of the area in 1978 with future projections made on growth trends of Apex and Wake Count.

The Apex growth rate of 27% during the 1970's was the third largest growth rate in Wake County. Apex's growth rate was 6% better than Raleigh's and 11.5% better than the state of North Carolina.

The number of persons per household in Apex is lower than the figures for Wake County and North Carolina as a whole. This reflects a large number of older households. Younger households, with children high school age or under, would tend to have a higher person-per-household average than the older families that have lost members to other localities. Newer subdivisions often have a preponderance of these younger families in them. If this is true, residents of the older sections of Apex must be appreciably higher than the general average. Apex's population is expected to increase from 2847 in 1980 to 9706 in 2005.

TABLE 1

Population Totals and Trends for the Apex Area			
Year	Wake County	Apex	Planning Area
1940	109,544	977	-
1950	136,450	1065	-
1960	169,082	1368	-
1970	229,006	2192	-
1978	310,357	2716	3955
1980	330,833	2847	4370
1990	476,400	3698	6447
1995	581,208	4253	7486
2000	686,016	4807	8524
2005	809,499	5433	9706

Economy and Employment

The economic activity of an area is to a great extent reflected in the traffic patterns of that area. The area's economic potential determines how many people it can support and hence the number of vehicles that it will have.

The planning area's 1978 employment by type and zone as determined by survey, is given in Table 2.

Although agriculture still plays an important part in Apex's economy, it is not the only support. Industry is the largest employment group. Industries in Apex include cosmetics, tool manufacturing, food processing and women's apparel.

The total of 5906 workers in 1978 is 149% of the planning area population. This relationship was assumed to remain the same over the duration of the planning period, and was used to project the number of persons who should be employed in 2000 and 2005. After employment projections were made, a breakdown of employment by zone and type was made based on projected land use. Zonal employment projections for 2000 and 2005 were inserted into the multiple regression equation used to estimate trip attractions (see Appendix A, Table 6) and the resultant attraction factors were used to distribute vehicle trips to traffic zones. The internal zone map is shown in Figure 4.

STUDY AREA POPULATION PROJECTION

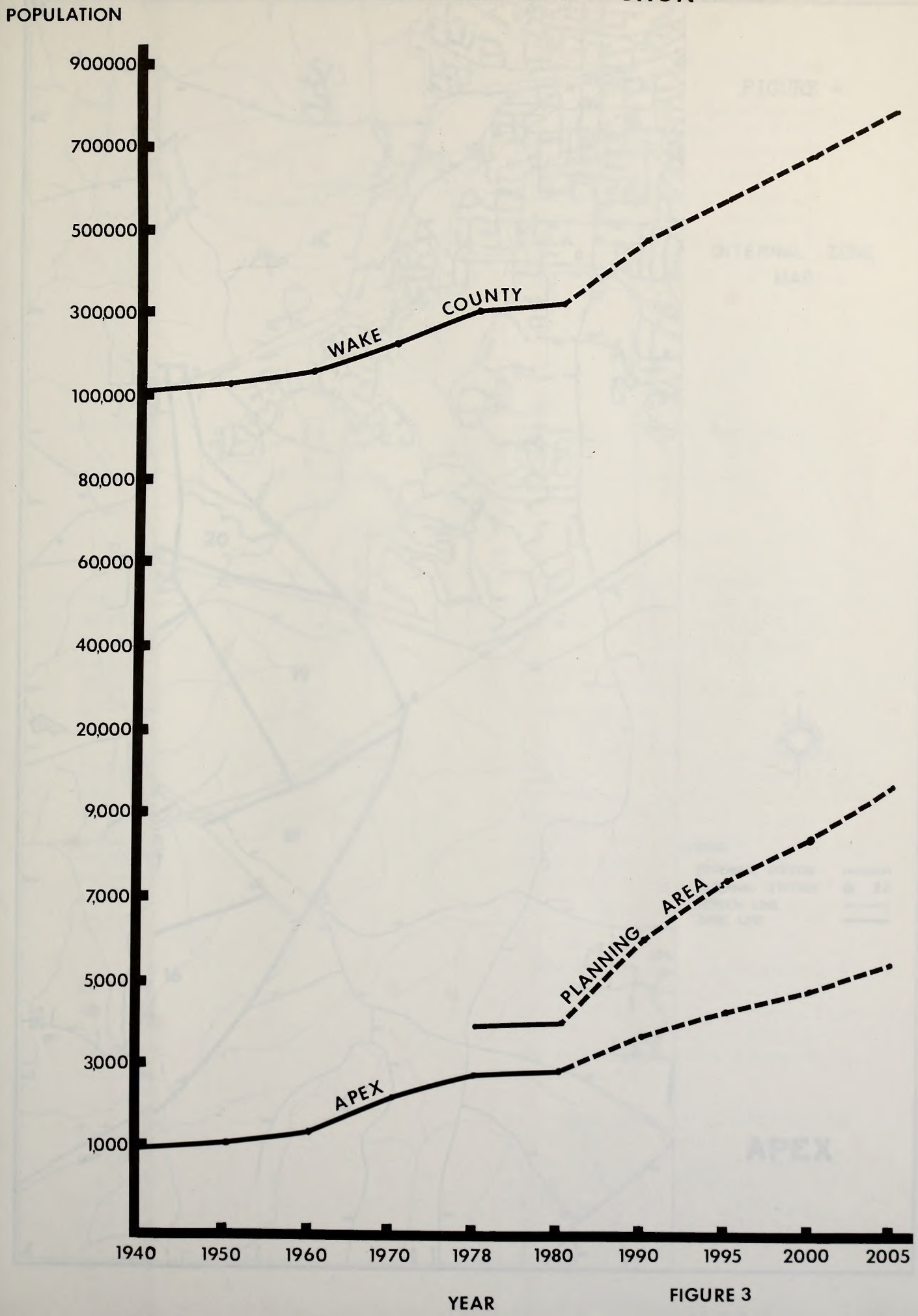


FIGURE 3

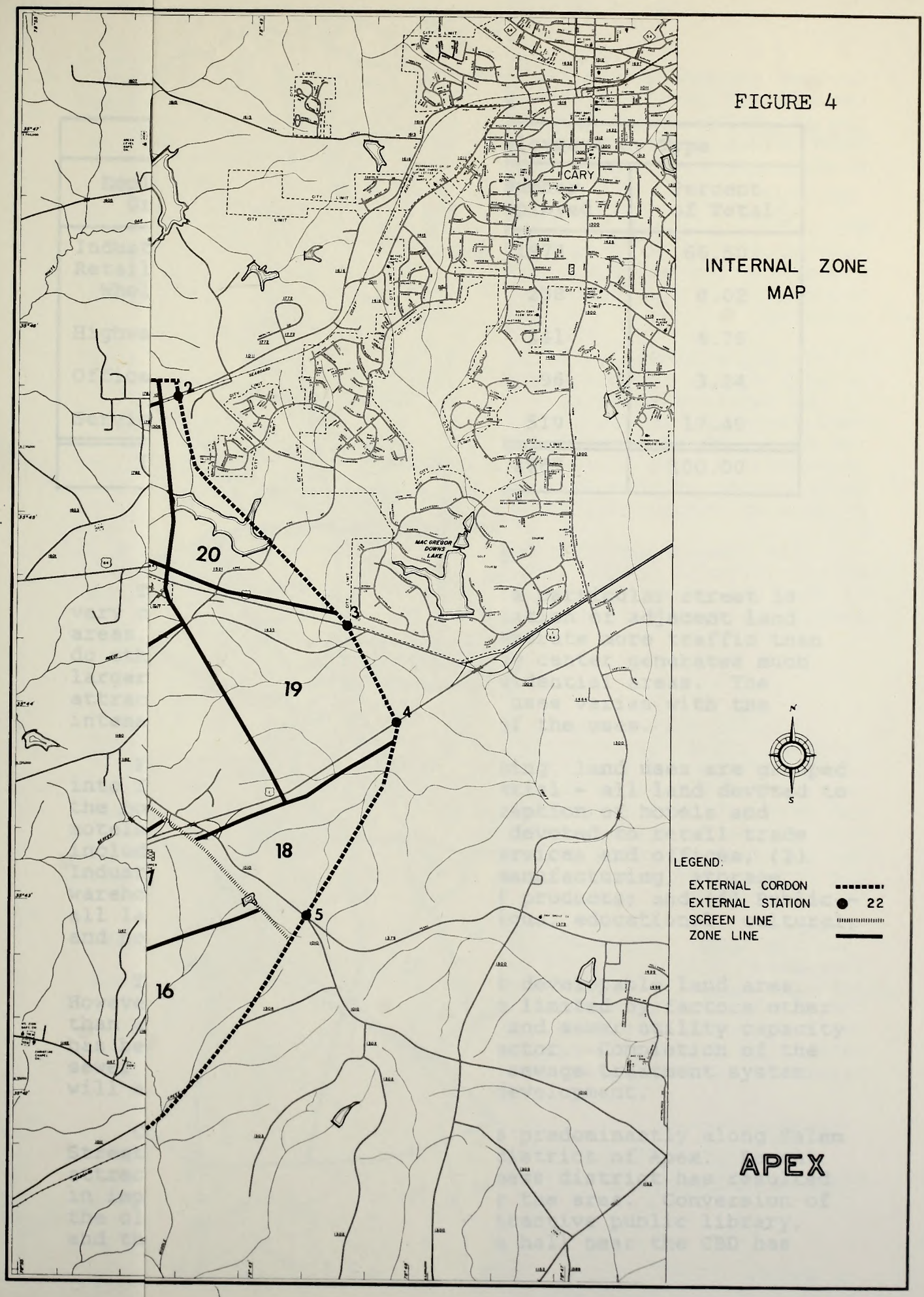


FIGURE 4

INTERNAL ZONE MAP

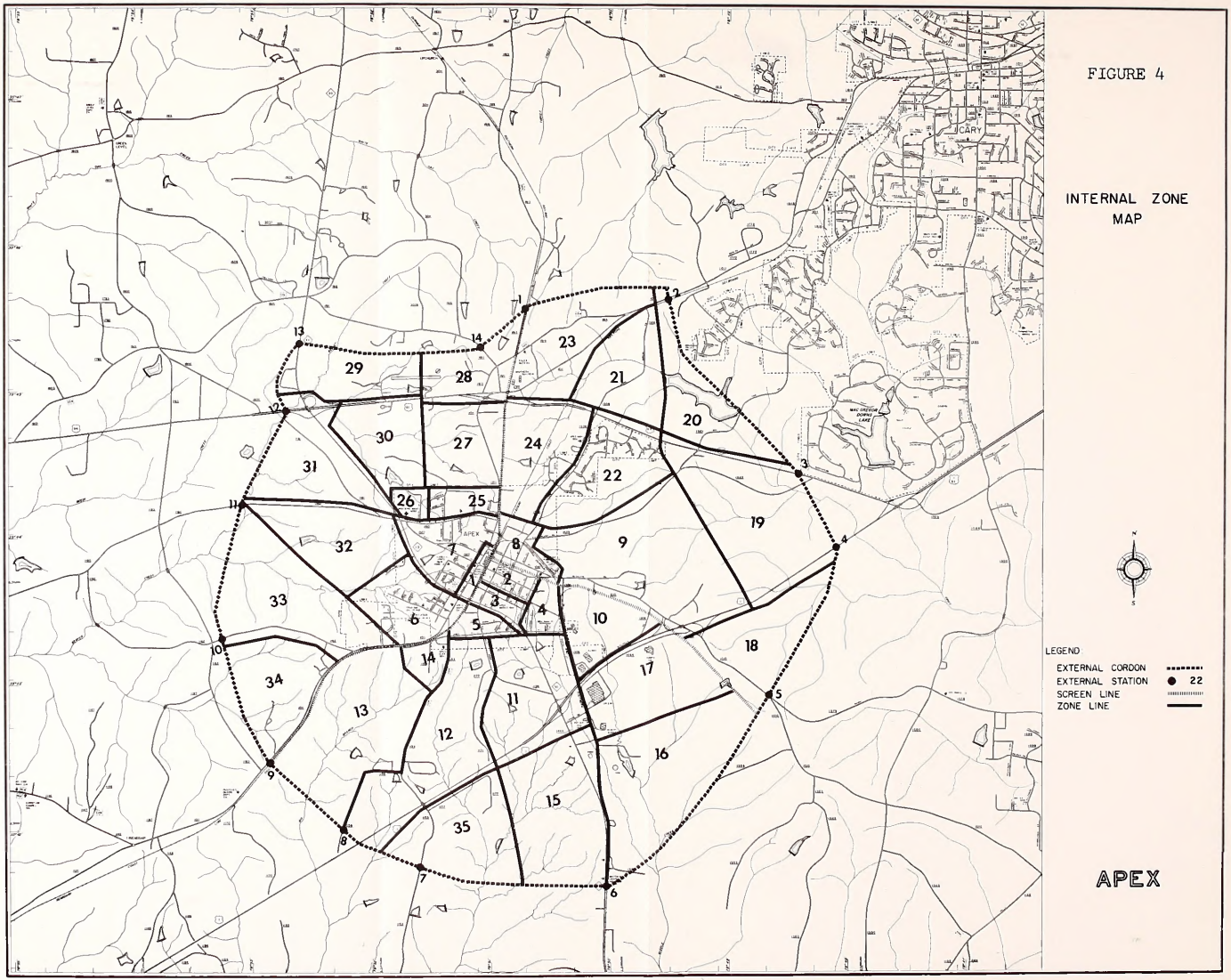


FIGURE 4

INTERNAL ZONE MAP

TABLE 2

1978 Planning Area Employment by Type			
Employment Group	SIC Codes	Number Employed	Percent of Total
Industry	1-49	1973	66.50
Retail and Wholesale	50-54,56-57, 59,55-58	238	8.02
Highway Retail	55-58	141	4.75
Office	60-67,91-94	96	3.24
Services	70-76,78-89,99	519	17.49
Total		2967	100.00

Land Use

The generation of traffic on a particular street is very closely related to the utilization of adjacent land areas. Some types of land uses generate more traffic than do others. For example, a shopping center generates much larger volumes of traffic than residential areas. The attraction between different land uses varies with the intensity and spatial separation of the uses.

For use in thoroughfare planning, land uses are grouped into four categories: (1) Residential - all land devoted to the housing of people with the exception of hotels and motels; (2) Commercial - all land devoted to retail trade including consumer and business services and offices; (3) Industrial - all land devoted to manufacturing, storage, warehousing, and transportation of products; and (4) Public - all land devoted to social, religious, educational, cultural, and political activities.

The Town of Apex has abundant developable land area. However, land use in Apex has been limited by factors other than availability. Limited water and sewer utility capacity has been the principal limiting factor. Completion of the sewer connection with the Raleigh sewage treatment system will allow an immediate spurt of development.

Commercial development exists predominantly along Salem Street which is the old business district of Apex. Recent attractive renovation of the business district has resulted in improved business potential for the area. Conversion of the old railroad depot into an attractive public library, and the construction of a new town hall near the CBD has

further encouraged its revitalization and perhaps assuring renewed and continued vitality and commercial potential for the old Apex business district. Other business areas in Apex are strip commercial establishments located along NC 55 south and Salem Street South.

Industrial operations have grouped in an area to the southeast of Apex. An attractive industrial park has been developed on both sides of US 1 with a number of buildings and attractive grounds. Extensive additional industrially zoned land is available in this area for selected additional industry.

Future industrially zoned land should be located in the same general south/ southeasterly quadrant of the planning area as the existing industrial pattern. The town of Apex has been fortunate in the grouping of industrial activities in one area. Residential and commercial land uses are often incompatible with close-by industrial locations, and a continuation of this fortunate grouping is advisable to avoid such incompatibilities into the future.[2]

The generalized future land use map shown in Figure 5 is not official in the sense of being an adopted plan, but it does illustrate a likely distribution of future land uses should the entire planning area become developed.

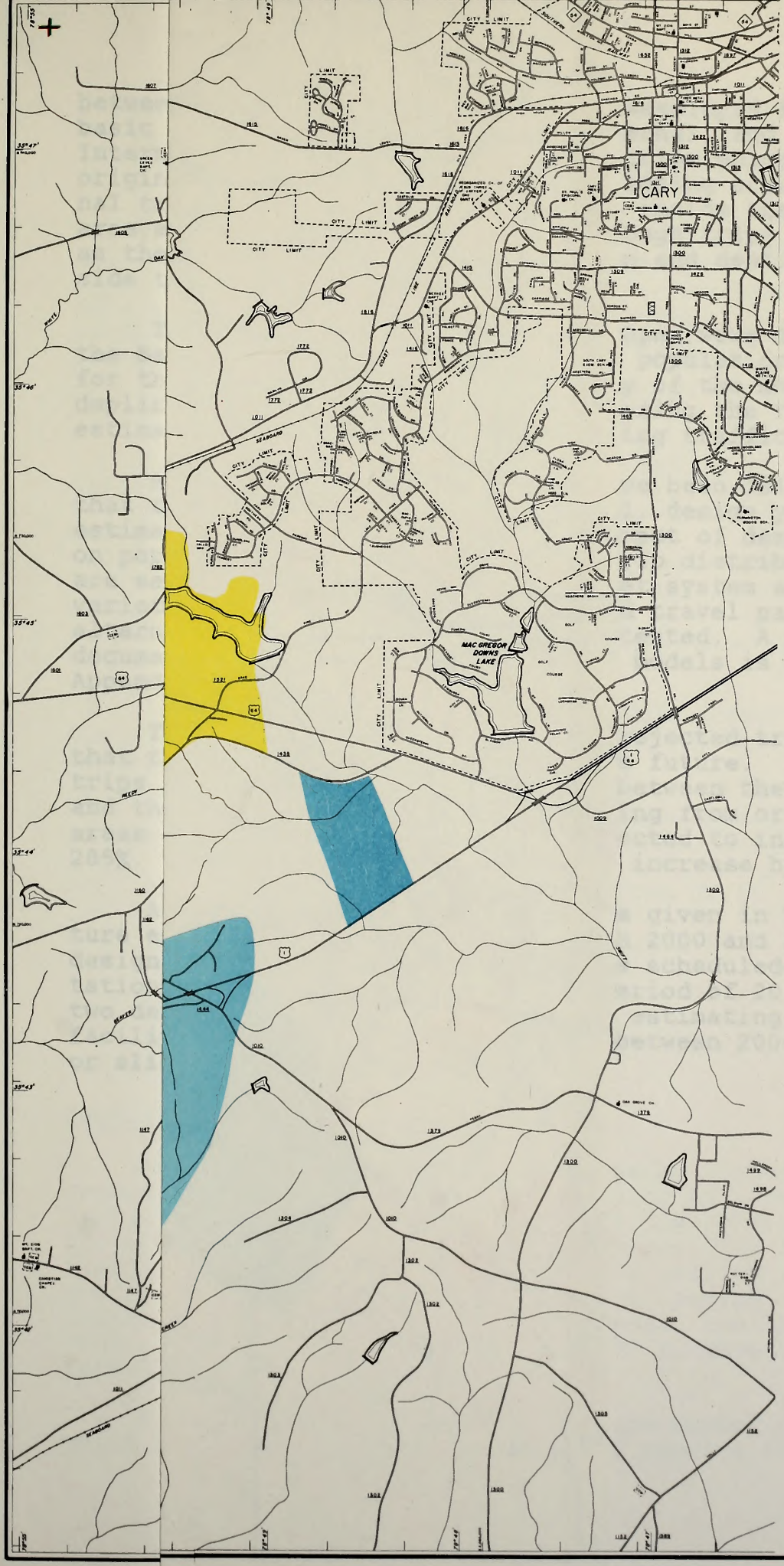
Travel

Traffic volume counts on existing streets show where existing travel is occurring. While these counts are useful in evaluating the physical ability of the existing system, they reveal little as to the actual travel desires (origins and destinations) of the motorist and they permit no evaluation of the functional sufficiency of the system. For thoroughfare planning purposes, a comprehensive knowledge of the origins and destinations of existing traffic and estimated future traffic is essential.

The type, intensity, and location of the population and employment within an area largely determined the travel patterns. The method used to predict future travel involves the development of mathematical models relating population and employment to travel. Models are developed to (1) estimate trips produced (origins) and trips attracted (destinations) to traffic zones and (2) to estimate travel patterns

---

[2]Triangle Council of Governments. Land Use Plan and Housing Element-Apex, 1977.



EXISTING AND FUTURE LAND USE

LEGEND

- RESIDENTIAL
- INDUSTRIAL
- COMMERCIAL
- PUBLIC-SEMI PUBLIC

APEX

FIGURE 5

further encouraged its revitalization and perhaps assuring renewed and continued vitality and commercial potential for the old Apex business district. Other business areas in Apex are strip commercial establishments located along NC 55 south and Salem Street South.

Industrial operations have grouped in an area to the southeast of Apex. An attractive industrial park has been developed on both sides of US 1 with a number of buildings and attractive grounds. Extensive additional industrially zoned land is available in this area for selected additional industry.

Future industrially zoned land should be located in the same general south/ southeasterly quadrant of the planning area as the existing industrial pattern. The town of Apex has been fortunate in the grouping of industrial activities in one area. Residential and commercial land uses are often incompatible with close-by industrial locations, and a continuation of this fortunate grouping is advisable to avoid such incompatibilities into the future.[2]

The generalized future land use map shown in Figure 5 is not official in the sense of being an adopted plan, but it does illustrate a likely distribution of future land uses should the entire planning area become developed.

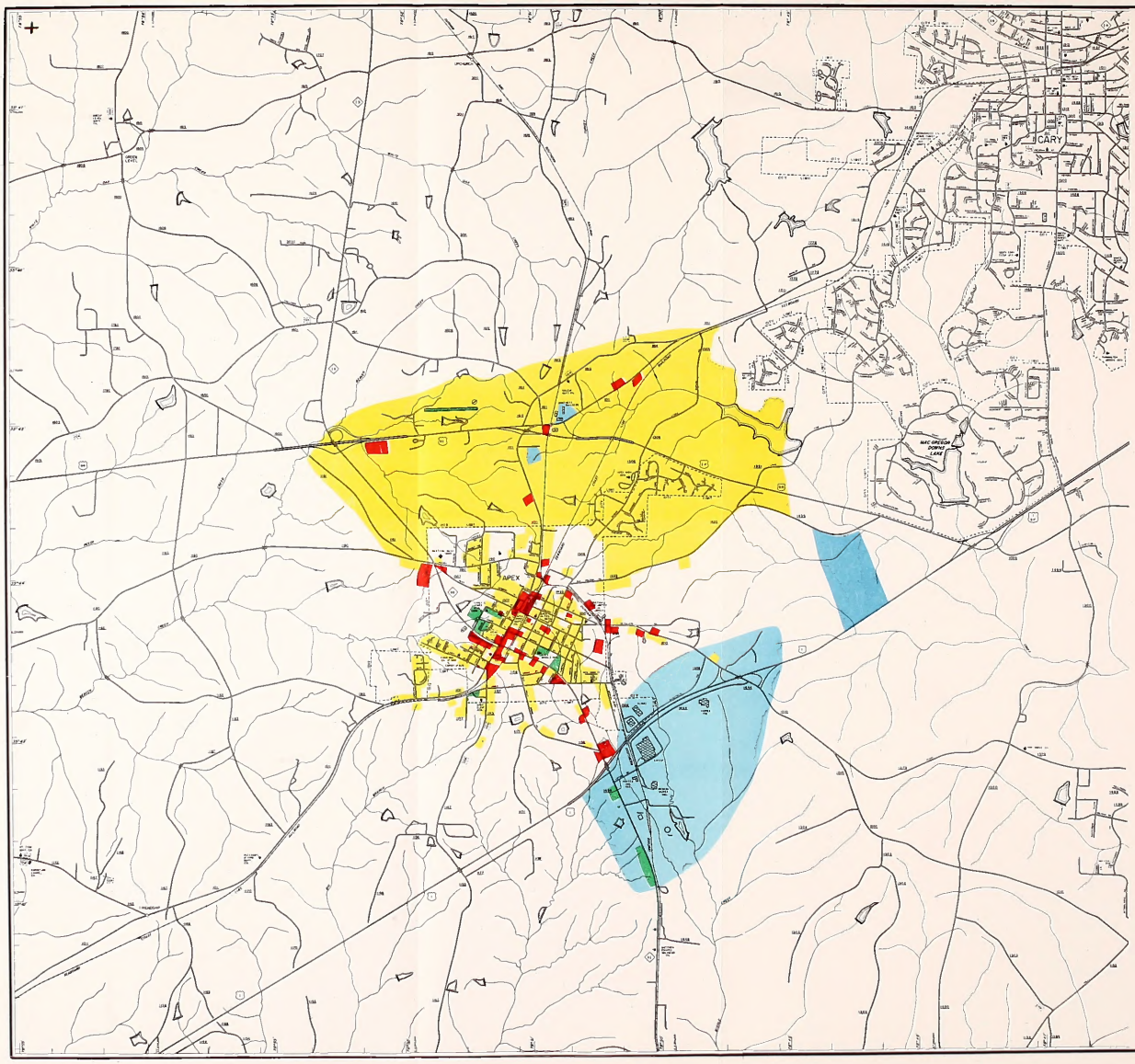
Travel

Traffic volume counts on existing streets show where existing travel is occurring. While these counts are useful in evaluating the physical ability of the existing system, they reveal little as to the actual travel desires (origins and destinations) of the motorist and they permit no evaluation of the functional sufficiency of the system. For thoroughfare planning purposes, a comprehensive knowledge of the origins and destinations of existing traffic and estimated future traffic is essential.

The type, intensity, and location of the population and employment within an area largely determined the travel patterns. The method used to predict future travel involves the development of mathematical models relating population and employment to travel. Models are developed to (1) estimate trips produced (origins) and trips attracted (destinations) to traffic zones and (2) to estimate travel patterns

---

[2]Triangle Council of Governments. Land Use Plan and Housing Element-Apex, 1977.



EXISTING AND FUTURE LAND USE

LEGEND

- RESIDENTIAL
- INDUSTRIAL
- COMMERCIAL
- PUBLIC-SEMI PUBLIC

APEX

FIGURE 5

between zones. Separate models are developed for the three basic types of trips: internal, external, and through. Internal trips are defined as those trips which have both origin and destination inside the planning area. An external trip is a trip which has one end inside the planning area and the other end outside. Through trips are defined as those trips which have both origin and destination outside the study area.

The travel forecast models for Apex were developed on the basis of travel, employment, and population data obtained for the base year 1978. The validity of the models to duplicate travel were tested by comparing the traffic volumes estimated by the models to the existing traffic volumes.

After travel forecast models have been calibrated such that they adequately duplicate travel, design year travel estimates are produced through the input of design year data on population and employment. The trip distribution models are sensitive to changes in the street system and some variation will occur in the estimated travel patterns as alternative future street plans are tested. A more detailed documentation of the travel forecast models is given in Appendix A.

This analysis of existing and projected travel indicates that trip-making will increase in the future. Internal trips are expected to increase 229% between the base year and the design year. Trips originating from or destined to areas outside the study area are expected to increase by 285%. Through trips are expected to increase by 250%.

A summary of the travel data are given in Table 3. Future estimates were prepared for both 2000 and 2005. Two design years were used since projects scheduled for implementation must have a specific design period of 20 years. The two design years provide a basis for estimating travel on a facility which may have design year between 2000 and 2005, or slightly outside the range.

TABLE 3

	Travel Data Summary		
	1978	2000	2005
Population	3955	8524	9423
Employment	2983	5976	6654
Average Daily Trips/Dwelling Unit	5.9	9.19	19.53
Internal Trips	8104	13,951	15,338
External Trips	31,864	71,210	78,452
Through Trips	40,250	44,890	54,038
Total # Trips	80,218	130,051	147,828

IV. DEVELOPMENT AND ANALYSIS OF THOROUGHFARE PLAN

Existing System

A Highway Needs Study conducted by the Planning and Research Branch for the Federal Highway Administration in 1970 resulted in the classification by primary use of all roads and highways in North Carolina. This classification of roads and highways has been monitored and updated as needed. US 64 and US 1 are classified as principal arterial routes; NC 55 and SR 1010 are major collector roads; SR 1011, SR 1153, SR 1160, SR 1611 and SR 1613 are minor collector roads.

The core of Apex is developed around a grid street system. The grid pattern is somewhat irregular and discontinuous. Salem Street and Mason Street provide for north-south movements through the center of the area. Culvert and Chatham Streets channel local traffic east to west. US 64, located north of the central business district, carries mostly through traffic east to west. US 1, located in the southeast section of the study area, provides through travelers with a bypass.

Currently, there are seven at grade street crossings of the Southern Railway that runs north-south through the center of Apex.

Improvements to the existing system made since adoption of the thoroughfare plan in Apex, include the following:

(1) Completion of US 1 Bypass from NC 55 to Moncure.

(2) US 64 from US 1 to Salem Church Rd.

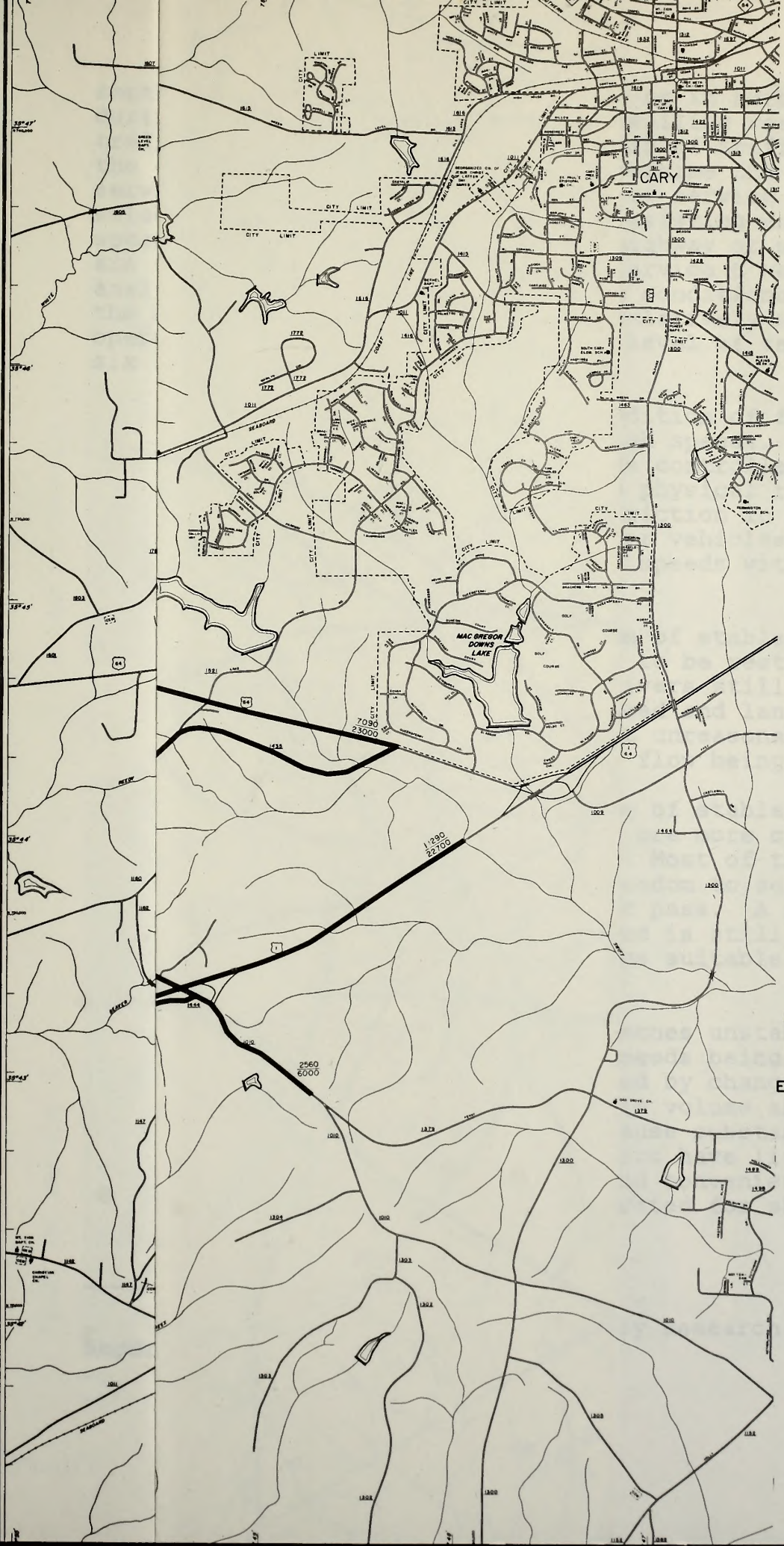
(3) Providing an interchange at US 64 and NC 55.

The existing major street system with 1978 and 2000 traffic volumes is shown in Figure 6.

Capacity Deficiency Analysis

An analysis was made of the existing street system to determine deficiences that would develop as a result of projected travel demands. This analysis involved comparing projected traffic volumes to street capability to carry traffic. In an urban area, a street's ability to move traffic is generally controlled by the spacing of major intersections, the width of the pavement, and the traffic control devices utilized. The ability to move traffic is termed "capacity".

Capacity is defined as the maximum number of vehicles which has a reasonable expectation of passing over a given



ALTERNATIVE PLAN

A

EXISTING STREET

SYSTEM

WITH 1978

AND

2000 ADTS'

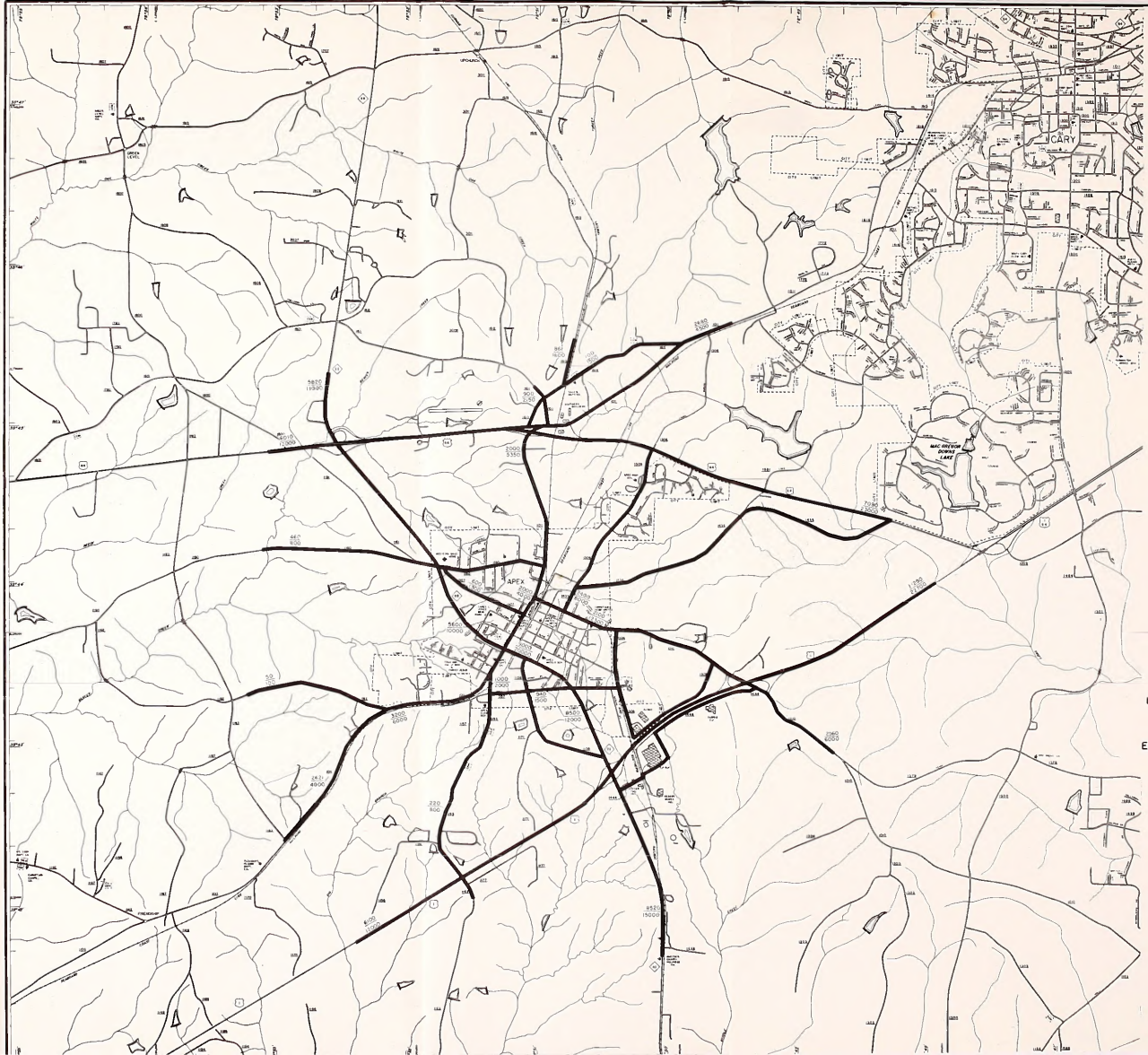
LEGEND

EXISTING STREET SYSTEM

1978 ADT / 2000 ADT — 000 / 000

APEX

FIGURE 6



ALTERNATIVE PLAN

A

EXISTING STREET SYSTEM WITH 1978 AND 2000 ADTS'

LEGEND

EXISTING STREET SYSTEM

1978 ADT / 2000 ADT — 000 / 000

APEX

FIGURE 6

ALTERNATIVE PLAN

A

EXISTING STREET

SYSTEM

WITH 1978

AND

2000 ADTS

LEGEND

EXISTING STREET SYSTEM

000
000

(1978 ADT
2000 ADT)

APEX

FIGURE 6

section of roadway in one direction, or in both directions, during a given time period under prevailing roadway and traffic conditions.[3] The relationship of traffic volumes to the capacity of the roadway will determine the level of service being provided. Six levels of service have been selected to identify the conditions existing under various speed and volume conditions on any highway or street. These are given in Figure 7. A Level of Service C was used in the analysis since it assumes congestion conditions tolerable to the majority of the population. A relatively satisfactory operating speed is attained at this level of service. The six levels of service are:

1. Level of Service A - A condition of free flow with low traffic volumes and high speeds. Traffic density is low, with speeds controlled by driver desires, speed limits, and physical roadway conditions. There is little or no restriction in maneuverability due to the presence of other vehicles, and drivers can maintain their desired speeds with little or no delay.

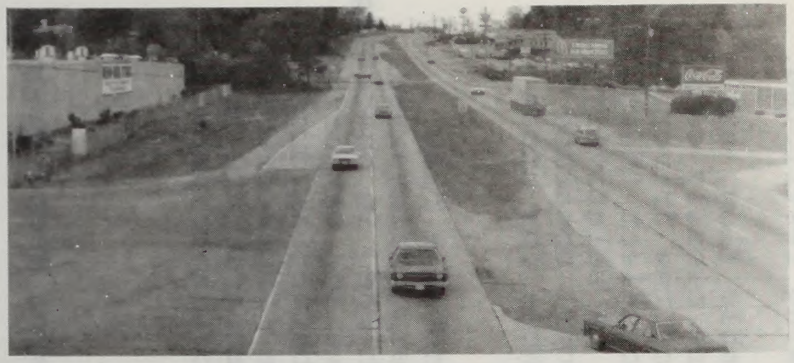
2. Level of Service B - A zone of stable flow, with operating speeds beginning to be restricted somewhat by traffic conditions. Drivers still have reasonable freedom to select their speed and lane of operation. Reductions in speed are not unreasonable, with a low probability of traffic flow being restricted.

3. Level of Service C - A zone of stable flow, but speeds and maneuverability are more closely controlled by higher volumes. Most of the drivers are restricted in their freedom to select their own speed, change lanes, or pass. A relatively satisfactory operating speed is still obtained with service volumes perhaps suitable for urban design practice.

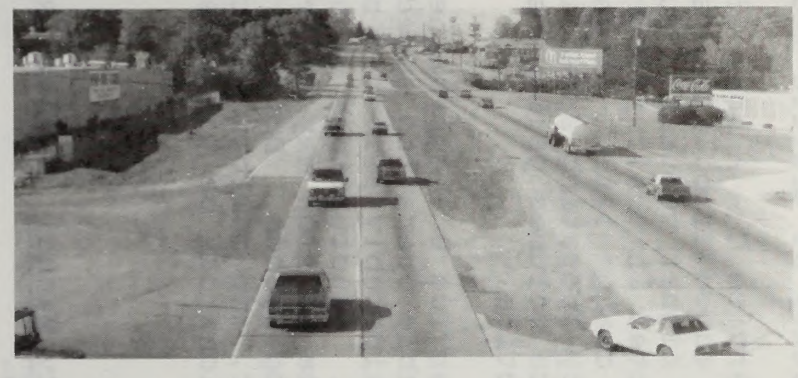
4. Level of Service D - Approaches unstable flow, with tolerable operating speeds being maintained though considerably affected by changes in operating conditions. Fluctuations in volume and temporary restrictions to flow may cause substantial drops in operating speeds. Drivers have little freedom to maneuver, and comfort and convenience are low, but conditions can be tolerated for short periods of time.

---

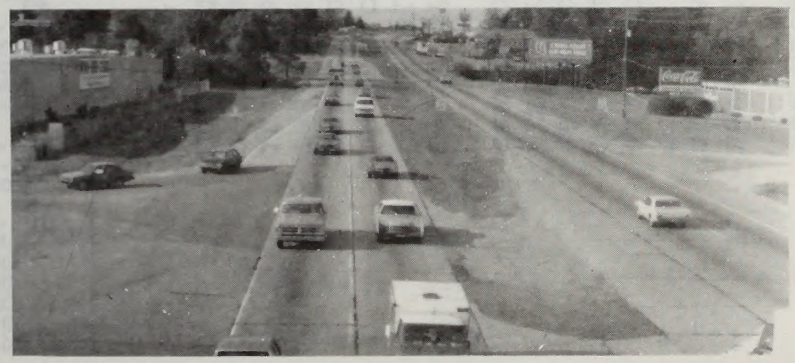
[3] Highway Capacity Manual, Highway Research Board Special Report, 87, 1965, p.5.



LEVEL OF SERVICE - A



LEVEL OF SERVICE - B



LEVEL OF SERVICE - C

LEVEL OF SERVICE - D

LEVEL OF SERVICE - E

LEVEL OF SERVICE - F

LEVELS OF SERVICE

FIGURE 7

5. Level of Service E - Represents operations at even lower operating speeds than in Level D, with volumes at or near the capacity of the Highway. At capacity, speeds are typically, but not always in the neighborhood of 30 mph. Flow is unstable, and there may be stoppages of momentary duration.

6. Level of Service F - Forced flow operations at low speeds, where volumes are below capacity. These conditions usually result from lines of vehicles backing up from a restriction downstream. The section under study will be serving as a storage area during parts or all of the peak hour. Speeds are reduced substantially and stoppages may occur for short or long periods of time because of downstream congestion. In the extreme, both speed and volume can be dropped to zero.

Existing streets that would have capacity deficiencies by the year 2000 are the following:

		Volume/Capacity Ratio
1.	US 64	2.30
2.	US 1	2.27
3.	NC 55	2.00
4.	Center St.	1.23

In addition to these areas of anticipated capacity deficiency is one area of system deficiency. System deficiencies contribute to capacity deficiencies by forcing drivers to take circuitous routes to their destinations, thus, increasing the congestion on the major radials.

In Apex, the major system deficiency is the lack of an adequate bypass for travelers on NC 55. This not only adds to the volume of traffic of this facility but also creates a mix of local and through traffic that is a main contributor to accidents and noise pollution.

Traffic Accidents

While system efficiency is very important traffic safety must also be seriously considered when developing a thoroughfare plan. Traffic accidents can be divided into this general type:

1. driver oriented
2. auto oriented
3. highway environment oriented.

Most accidents are predominantly driver oriented although each of these sources usually make some contribution to the accident.

Accident records for 1978-1980 were studied as part of the thoroughfare planning study. The fifteen highest accident locations are shown in Table 4.

TABLE 4

Accident Location	No. of Accidents
NC 55 & US 1	8
NC 55 & Hugh Street	9
NC 55 & James Street	14
NC 55 & Salem Street	17
NC 55 & Tunstall Street	6
Center St. & Mason St.	5
Center St. & Salem St.	7
NC 55 & Hunter St.	3
NC 55 & W. Mason St.	3
US 64 & Lake Pine Dr.	3
First St. & Lynch St.	3
Holloman St. & Salem St.	4
Salem St. & West St.	6
Salem St. & Chatham St.	3
Salem St. & Moore St.	3

Consequences of "Do Nothing" Alternative

A "do nothing" alternative was considered in weighing the desirability of developing a thoroughfare plan. Some major advantages of doing nothing are:

1. No capital investment.
2. No construction traffic disruption.
3. No noise, air or water pollution due to construction.
4. No removal of shrubs or trees.
5. No additional land acquisition.
6. No displacement of people or businesses as a result of construction.

However, there are a number of disadvantages to a "do nothing" policy which have significant adverse effects on the urban environment. They are:

1. Increasing traffic volumes and congestion on major streets which will cause traffic to divert to residential streets.
2. Existing "bottleneck" situations will become worse.
3. Social, health, and safety standards will deteriorate.
4. Increased road use costs.
5. Increased driving time.
6. Increased accidents.

7. Increased air pollution and noise pollution induced by traffic congestion.
8. Reduced mobility for emergency vehicles.
9. Increased transportation costs for businesses.
10. Reduced retail sales as a result of increased congestion, reduced accessibility, and higher transportation costs.
11. Increased driver and public frustration due to congestion.

The "do nothing" concept, while an alternative, is not a viable alternative in transportation planning for Apex in light of the above defined problems.

Goals and Objectives

A random sample of 25 individuals returned completed goals and objectives survey forms. Thirty-five items were presented for evaluation that are typically considered in development of a thoroughfare plan. Individuals were asked to evaluate the importance or desirability of each item on a scale which varied from "Not Important" or "Not Desirable" to "Most Important" or "Most Desirable". The scale used was as follows:

Not Important	Neutral	Important	Very Important	Most Important	
(-1)	(0)	(0)	(2)	(3)	- Assigned Numerical Value

Upon completion of the survey, numerical values were assigned to the scale and results of the survey were tabulated. The results are shown in Table 5.

Values can be defined as the system of preferences which govern the actions taken by society. Goals are usually considered to be values which have been expressed as a set of statements as to what is desired. Objectives are tangible acts which are stated in such a manner as to permit appraisal of progress toward goals.

The analysis of the goals and objectives survey yielded the following general ranking of goals:

1. Sidewalks and access to central business areas were considered the most important items.

2. Cost of travel, traffic safety, land use zoning, attractive roads and bridges and neighborhoods were considered next in importance.

TABLE 5

GOALS AND OBJECTIVES SURVEY

Relative Importance or Desirability of Community Value Factors			
Rank	Value Factor	Value	
1	Sidewalks	2.08	Most Important(3
2	Access to central business area	2.02	
3	Cost of travel	1.84	Very Important(2
4	Traffic Safety	1.82	
5.	Land use zoning	1.78	
6	Attractive roads and bridges	1.68	
7	Neighborhoods	1.64	
8	School travel	1.64	
9	Noise caused by vehicles	1.46	
10	Access to homes	1.46	
11	Travel time	1.46	
12	Access to industry and shopping centers	1.42	
13	Construction cost of transportation system	1.40	
14	Parks and playgrounds	1.26	
15	Home to work travel	1.22	
16	Air pollution caused by vehicles	1.14	
17	Bus transit	.96	
18	Trees and shrubs along streets	.82	
19	Scenic travel ways	.62	
20	Long, narrow strips of commercial development along thoroughfares	.60	
21	Bicycle travel	.58	
22	Taxi service	.34	
23	Parking on heavily traveled streets	-.34	
24	Improve traffic flow at intersections	-.92	

3. School travel, noise caused by vehicles, access to homes, and travel time composed the third priority ranking.

4. Access to industry and shopping centers, construction costs of transportation system, parks and playgrounds, home to work travel, and air pollution caused by vehicles were the next group of priorities.

5. Parking on heavily traveled streets and improve traffic flow at intersections were viewed negatively.

Priorities for specific actions or objectives are as follows:

1. Improve conditions at railroad crossings.
2. City control over subdivision of land.
3. Off street loading areas for trucks.
4. Special routes for trucks.
5. Improve traffic flow at intersections.
6. Improve transportation system to attract industry.
7. Restrict access along major thoroughfares.
8. Limit number of commercial signs along roads.
9. Urban renewal.
10. Bicycle route.
11. Preservation of historic buildings.

Alternate Plans

The process of developing, testing and evaluating alternate plans involved a number of considerations. These included area goals and objectives, identified deficiencies, environmental impacts, existing and anticipated land development and travel service. Travel forecasts provided a basis for evaluation of alternatives as the ability to serve future travel needs. Aerial photography, topographic mapping, field reconnaissance and discussions with city officials provided a basis for evaluating the feasibility of alternate alignments and their potential impacts.

Non Construction Alternates

Non-construction improvement techniques include such things as eliminating on street parking, improving traffic signal coordination and restricting turning movements.

Presently, Apex's traffic situation doesn't warrant any of these suggestions. But, in the future; as population, industry and traffic increases, these minor improvements could significantly aid the egress and ingress of traffic through the Apex study area.

Plan A - Improved Existing Major Street System

Alternate Plan "A" consists of the major street system. This system is the network of streets available to serve 2005 travel desires if no new facilities are considered. Alternate "A" is useful to illustrate existing and expected future locations of capacity deficiencies through the assignment of both existing and projected design year traffic on the existing network.

Existing streets would be widened when traffic volumes exceed street capacity. The costs incurred by Plan "A" are those of maintenance and widening of the existing streets.

Existing streets that would be substantially widened under Plan "A" are:

(1) NC 55 from the western edge of the city limits to the cordon.

(2) US 64 from US 1 to the western edge of the city limits.

(3) US 1 from US 64 to cordon.

(4) SR 1010 from Salem St. to US 1.

Plan "B" - Existing Thoroughfare Plan

Alternate Plan "B" was developed in 1967 using land use studies and practical applications of accepted thoroughfare concepts, combined with experienced professional judgement. No origin-destination survey was conducted at the time and therefore no computer simulation of future traffic volumes was performed.

Under this plan, the following new streets were recommended:

(1) A two lane loop facility;

(2) Pearson St. extension from US 64 to Hunter St; and from SR 1162 to West Chatham ST;

(3) Chatham St. extension from Tunstall Ave. to SR 1010;

(4) Sanders St. extension from Tunstall ST. to Chatham St. extension;

(5) Connecting both ends of Mason St. by moving an offset intersection.

Plan "C"

Alternate Plan "C" incorporates a portion of Plan "B" with some changes to produce a workable plan.

Under Plan "C", the following new streets were recommended:

(1) A two lane loop facility.

(2) Hunter St. extension from Salem St. to Center St.

(3) Outer loop from beyond the southeastern cordon to beyond SR 1011.

(4) Pearson St. extension from US 64 to Hunter St.; and from SR 1162 to West Chatham St.

The following streets would be substantially widened under Plan "C""

(1) NC 55 from the western edge of the city limits to the cordon.

Plan D - Recommended Thoroughfare Plan

Alternate D is the result of alterations made to Alternate A, B, and C by local and state planning staff (see Figure 10). It reflects social and environmental concerns while at the same time more closely conforms to the concepts of an idealized thoroughfare plan (see Figure 1). An inner city loop provides for better local traffic movement. The Outer Belt Loop doubles as a Bypass for southern Wake County and also as a NC 55 Bypass. Old Raleigh Road Connector and the NC 55 and SR 1010 Connector provides direct access to other facilities and opens new lands for potential development. Widening under this alternative would be similar to that for other alternates.

Evaluation of Alternative Plans Relative to Environmental Impacts

The evaluation of alternative plans relative to environmental impacts can be separated into three broad areas - physical environmental considerations, social and/or cultural environmental considerations, and economic environmental considerations.

Physical Environmental Considerations

Environmental factors relating to the physical environment include: (1) air quality, (2) water resources, (3) soils and geology, (4) wildlife and (5) vegetation.

Air Quality - Air quality studies have reported that the internal combustion engine in motor vehicles caused approximately three-fourths of the carbon monoxide (C)), half the hydrocarbons (HC) and nearly half the nitrogen oxides (NO_x), in the atmosphere. Since the passage of the Federal Clean Air Act of 1967, there has been extensive research for means to reduce these pollutant emissions. The Federal government has set increasingly stringent standards on emissions from new automobiles. By 1978 all new automobiles were equipped with control devices that substantially reduced emissions by 90% over 1970 vehicles.

The design of a thoroughfare system can have a significant effect on the amount of pollutants added to the atmosphere. Most pollutant emissions are reduced whenever traffic is permitted to flow smoothly. One exception to this rule is NO_x which increases at high operating speeds. NO levels are usually low compared to CO and HC, so it is still desirable to work toward rapid, smooth traffic flow.

An evaluation of alternative plans was made by comparing the pollutant emissions resulting from implementation of alternative plans. Air pollutant emission factors were calculated for different calendar years and different average speeds by using "Mobile II: Mobile Source Emission Model", a computer program supplied by the Environmental Protection Agency. The emission factors were multiplied by vehicle miles of travel (VMT) per speed increment per day and 365 to give the estimated total pounds of pollutants emitted by motor vehicles per year. The results are given in Table 6.

Water Quality and Conservation

Water quality is a prime asset of all cities and every effort should be made during highway construction to adhere to recommended guidelines to insure the prevention of pollution. Guidelines have been issued outlining procedures for maintaining water quality and the reduction of possible soil erosion occurring during and following highway construction. Obviously, the greater the extent of new construction, the more serious will be the problems relating to conservation and water quality. Guidelines for maintaining water quality should include: (1) control of soil erosion and siltation; (2) control of waste disposal areas during construction; (3) allowing entering of live and impounded waters only within construction limits; (4) no deposition of any construction materials or pollution agents such as fuels, lubricants, bitumens, and sewage in traversed waters; (5) proper drainage of all borrow pits and ditches; and (6) inclusion in project plans for adequate drainage control on the constructed facility and for waters traversed by the project.

The Town of Apex has a water supply and treatment plant that is capable of supplying most of the water needed by the

TABLE 6

Estimated Average Motor Vehicle Pollutant Emissions[a]						
Year	Alternate	CO Kg/Day	HC Kg/Day	NO Kg/Day	VMT/Day	Vehicle.-hours per day
1978	Existing System	12,309	1,586	2,269	238,560	6.679
2005	A	10,090	933	2,144	381,326	13,346
2005	B	10,897	1,008	2,315	411,818	14,414
2005	C	12,552	1,161	2,667	474,357	16,602
2005	D	13,887	1,284	2,950	524,827	18,369

[a]Emission factors derived from the "Mobile II" are pollution program using 80.3% light duty vehicle, 5.8% light trucks, 3.1% heavy duty trucks and 0.5% motorcycles. Light duty diesel vehicles went from 0.5% in 1980 to 10% by year 2000. 60¼F, 21.0% factors were used.

town. An interconnection with the Town of Cary allows this local supply to be supplemented during times of emergency or low flow.

The Apex system has been connected since 1974 to that of the Town of Cary, which in turn is largely supplied by the City of Raleigh's system. The Cary connection will supplement Apex's own continued production. Water was first purchased by Apex from Cary in the extremely dry fall of 1976, when the contents of the Apex reservoir fell to an estimated 10 MG. The Raleigh system was in dire straits itself because of the drought, however, and the Apex reservoir was supplemented by an emergency connection with a nearby soil conservation lake.

Raleigh's position as a major water supplier has improved with the filling of its Beaver Dam Creek reservoir during the 1976-77 winter. Increased filtration plant capacity is still being considered in Apex, however, because Apex can currently produce water more economically than it can purchase finished water from Cary. The Williams Creek reservoir site has been developed to its maximum, the impoundment's capacity was enlarged by silt removal and dredging, and the safe yield has also been somewhat increased. In the future, however, Apex will have to rely more heavily on water supplied by the greater Raleigh system because growth and development will soon far exceed the local treatment capability.

The countywide water system supplied by Raleigh from the Falls of the Neuse Reservoir is expected to satisfy Apex's water needs through the end of the planning period. Should the Fall's Reservoir be substantially delayed, the proposed Jordan Reservoir could provide Apex with water, either directly or as the source of an alternative county supply system.

Alternative Plan C is the only plan that would have an adverse effect on the Apex water quality. The proposed outer loop facility would require that the Town's water tower be relocated.

Soils and Geology

The soils in the Apex planning area are located in the Mayodan-Granville-Creedmoor association. This association is characterized by gently sloping to moderately steep, deep or moderately deep, well-drained and moderately well-drained soils that have a subsoil of friable sandy clay loam to very firm clay; derived from sandstone, shale, and mudstone.

A majority of the town is built on Mayodan type soil. Mayodan soils are characterized as fair sources of topsoil or roadfill, and have only slight limitations for the siting of homes. Because of a moderate percolation rate, there is moderate limitation on the use of these soils for septic

tank absorption fields. There is only slight limitation in the location of recreation facilities on these soils.

In one area to the south of Apex along Highway 55, where industrial zoning has been established, the predominant soil is Creedmoor sandy loam. This particular Creedmoor loam with two to six percent slopes has severe limitations for the construction of dwellings and for installation of septic tank filter fields. The high shrink-swell potential of the soil makes for residential construction problems and the extremely slow permeability limits septic tank use. Such soils also have high corrosivity for uncoated steel and concrete. Because of poor drainage, texture, and acidity, steel and concrete should be protected. Because of these factors it is unlikely that residences would ever be built in this area. Under the industrial classification, engineers for any facility proposed on this should be alerted to and be conscious of the soil limitations. Particularly they must be alert to the shrink-swell factor and the problems of paving over such areas. Also, particular attention should be paid to the need for enlarged cross-section and reinforcing of building footings.

Wildlife and Vegetation

Most of the land in the Apex area is heavily forested. These areas consist of a mixture of pine and hardwoods. Field crops include tobacco, cotton, soybeans, grain and hay.

Rabbits, deer, raccoon, opossum, weasel and skunks all occupy the woodlands. Bobwhite quail, doves, wild turkeys and ducks are sometimes seen on the open farmland. Cottontail rabbits and squirrels are other small game. There appears to be no big game in the area except for an occasional white-tail deer.

Alternate A non-construction will have the least short term impact on wildlife and vegetation. Alternatives B, C and D will have the greatest impact initially, due to the larger amount of road construction. Wildlife and vegetation in the woodlands will be affected most.

Noise Levels

Implementation of the Recommended Thoroughfare Plan should have an overall positive effect on the noise level created by vehicles using the system. The noise level of some streets is expected to rise due to increased usage. Adverse noise conditions are more prevalent in areas of high traffic congestion and on facilities that are functionally misused. It is the objective of the thoroughfare plan to reduce congestion and therby either lower or maintain existing noise levels, even though there will be more vehicle trips

on the street system. The areas of greatest concern in the implementation of the thoroughfare plan are schools, churches, hospitals, and residences where street widening will reduce set back distances.

Areas throughout the system may receive a moderate increase in noise levels assuming no improvements are made to vehicles which utilize these routes (numerous research projects underway are aimed at a reduction in noise emission for future vehicles). The Recommended Thoroughfare Plan will help reduce anticipated noise levels by reducing congestion (stop-and go-driving) on the street system.

During today's highway design process, engineers are taking into consideration noise levels created by highway improvements. Recent research is providing techniques to predict the noise level created by highway improvements and offer measures such as elevating or depressing the roadway, providing different roadway surfaces, and installing acoustical barriers to reduce noise levels. Highway projects undertaken by the Division of Highways now have noise prediction analysis made during the planning stage. By comparing these noise predictions with current noise standards, the engineer can forecast possible areas of excessive noise pollution and take adequate steps to reduce their occurrence.

Plan D will redirect the through traffic that normally takes NC 55 onto the proposed Outer loop. Thus, the CBD will experience less noise and congestion.

Churches and Educational Facilities

None of the alternative plans call for the relocation of any schools or churches in the study area. Plans A, C, and D will require some additional right of way of church land. The proposed improvement should provide better accessibility of the patrons of the affected churches as well as those which are not directly affected.

Parks and Recreational Facilities

Projects proposed by the alternative plans will have no adverse effect on the recreational areas located in the study area.

Natural and Historic Landmarks

The federal government has issued guidelines requiring all State Highway Departments to take special efforts to preserve public parks, recreation areas, and historic sites. Such lands are not to be used for highway purpose unless there is no feasible alternative. The Federal Highway Administration has interpreted these guidelines as protecting not only historic sites but also any setting or surrounding

areas that might be adversely affected by a highway project. In all the thoroughfare plans, care should be taken in every construction project to make certain all historic sites and natural settings are preserved.

Public Health and Safety

A transportation system can contribute to the public health and safety of a Town through: (1) a reduction in traffic accidents, (2) improved access to medical facilities; and (3) improved mobility for fire, police, and other emergency vehicles.

Plan "A" would contribute the least to improving traffic safety and mobility by tolerating more congestion and by concentrating large volumes of traffic on a few major streets. Plans "B", "C" and "D" would provide better access in and around the area in various degrees.

National Defense

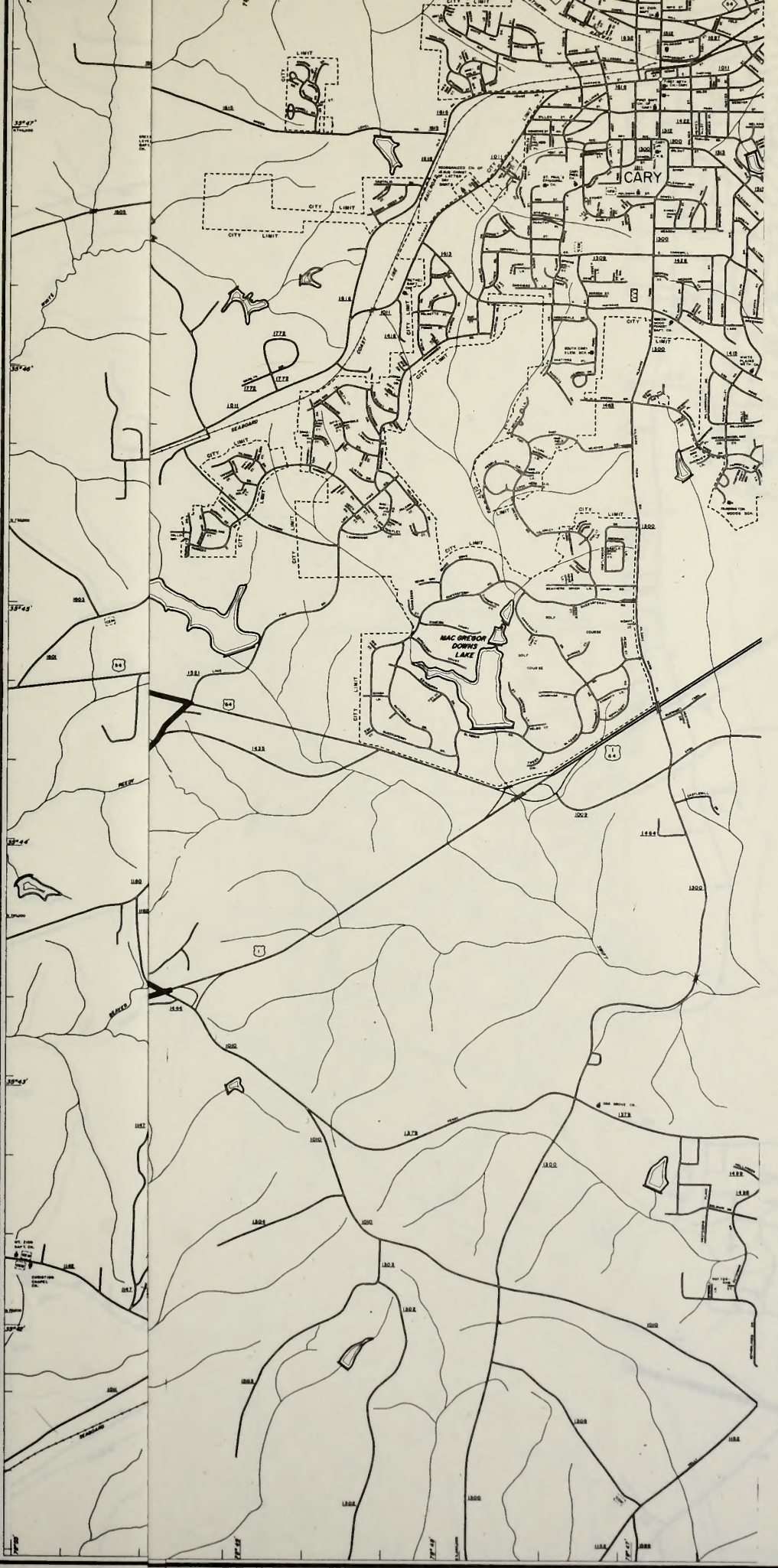
In accordance with "Federal Aid Highway Program Manual" Volume 6, Chapter 10, Section 2, the North Carolina Department of Transportation has designated US 1 and US 64 as part of the National Defense Highway System.

The recommended plan provides an excellent system for efficient evacuation and movement around and within the study area.

Aesthetics

Providing a facility which is adequate, safe and compatible with both the natural and man-made environment is one of the goals of a highway designer. Each of the alternative plans, especially the recommended plan, will offer certain improvements over the existing conditions on several of the streets in the urban area. The recommended improvements will in some cases replace unsightly shoulder sections which have broken pavement edges and open ditched with aesthetically more pleasing curb and gutter sections.

On some of the streets where widening is recommended, it will be necessary to disturb and/or remove some portions of residential lawns. In order to retain the natural beauty of these areas, care should be taken during planning and construction to maintain the scenic beauty.



ALTERNATIVE PLAN

B

EXISTING THOROUGHFARE PLAN

LEGEND

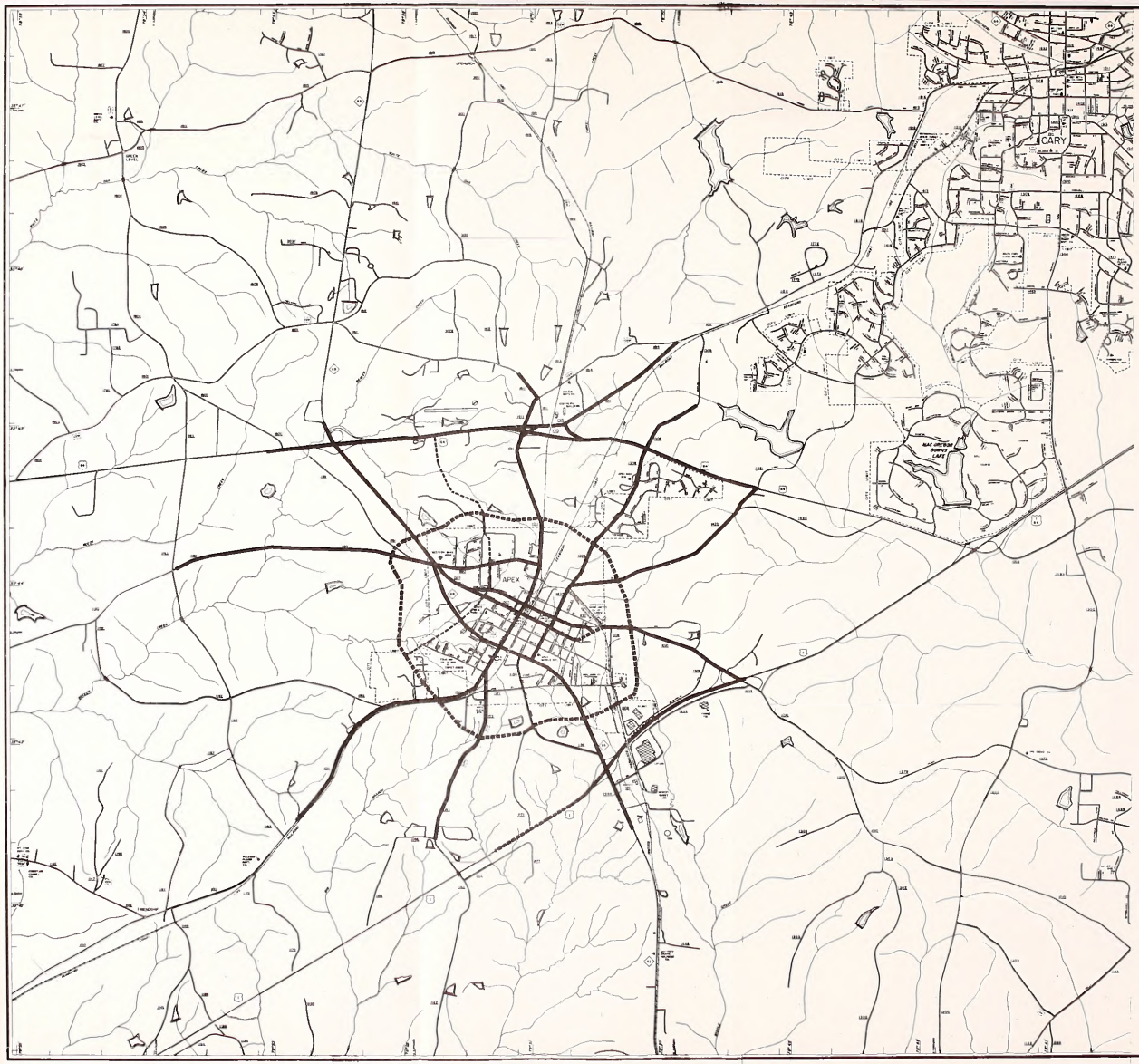
	EXISTING	PROPOSED
MAJOR	▬▬	▪▪▪
MINOR	—	- - -

N

S

APEX

FIGURE 8



ALTERNATIVE PLAN

B

EXISTING THOROUGHFARE PLAN

LEGEND

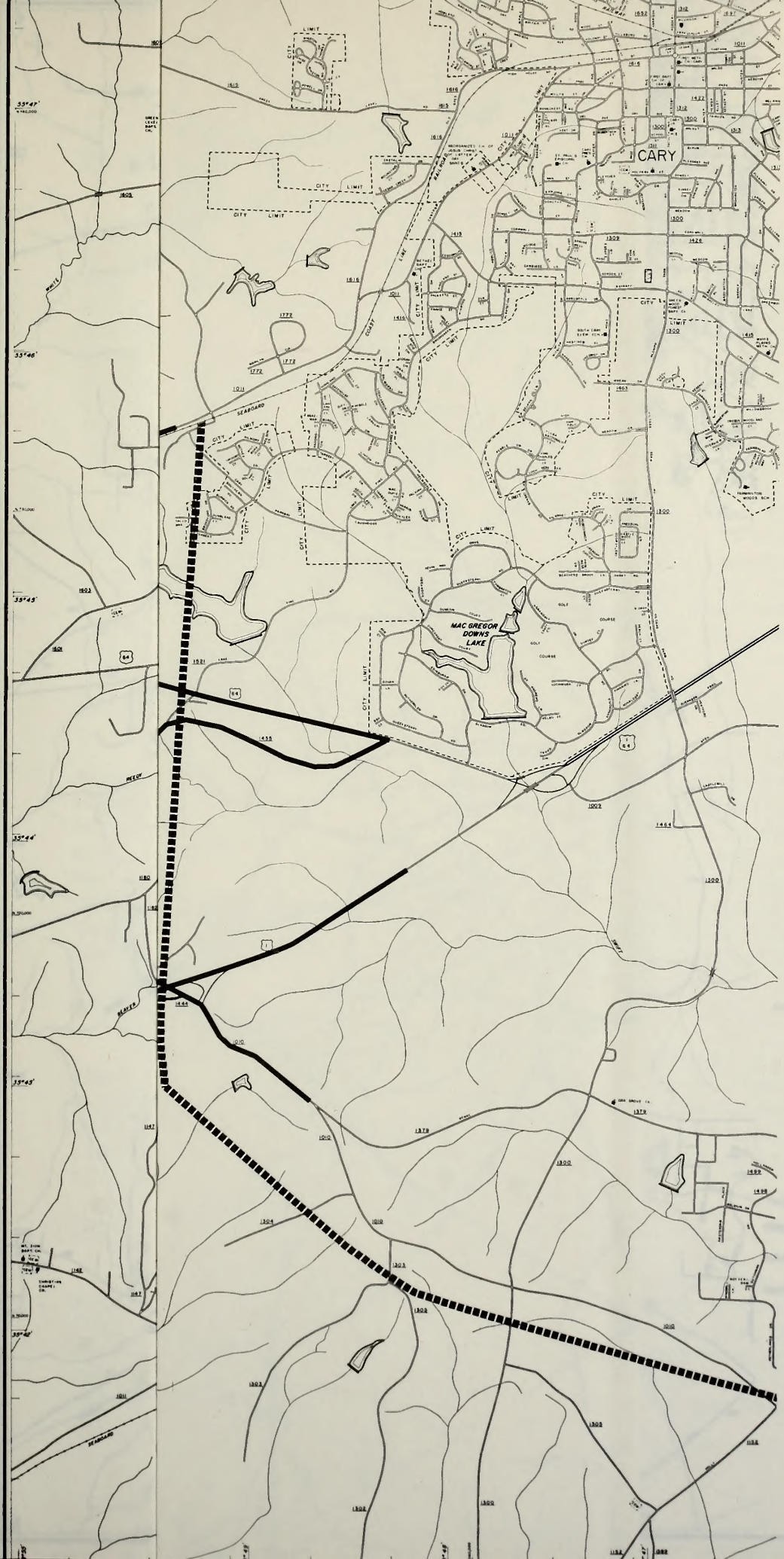
	EXISTING	PROPOSED
MAJOR	▬	▪▪▪
MINOR	—	- - -

N

S

APEX

FIGURE 8



ALTERNATIVE PLAN

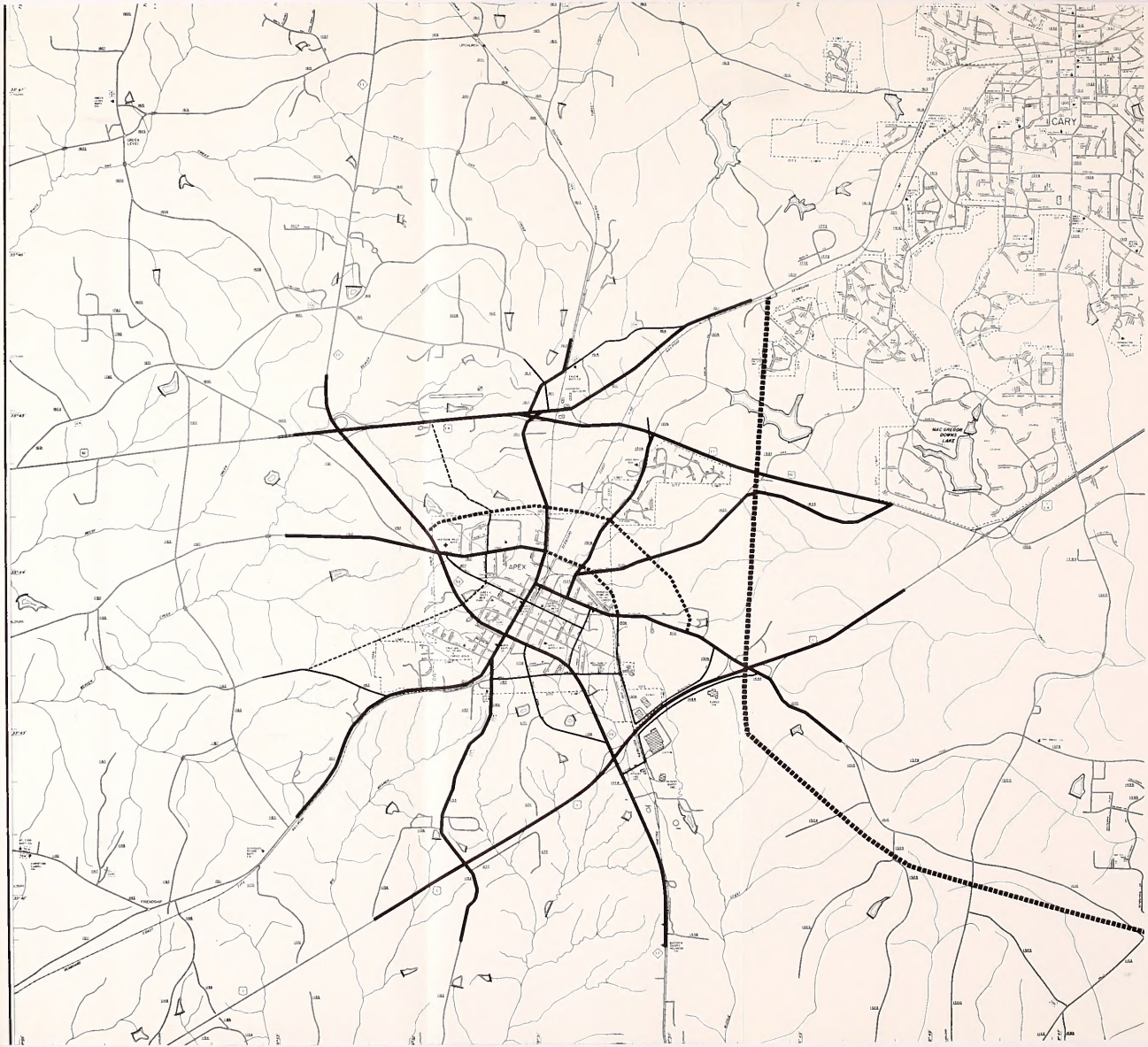
C

LEGEND

	EXISTING	PROPOSED
MAJOR	▬▬	▪▪▪▪
MINOR	——	- - - -

APEX

FIGURE 9



ALTERNATIVE PLAN

C

LEGEND

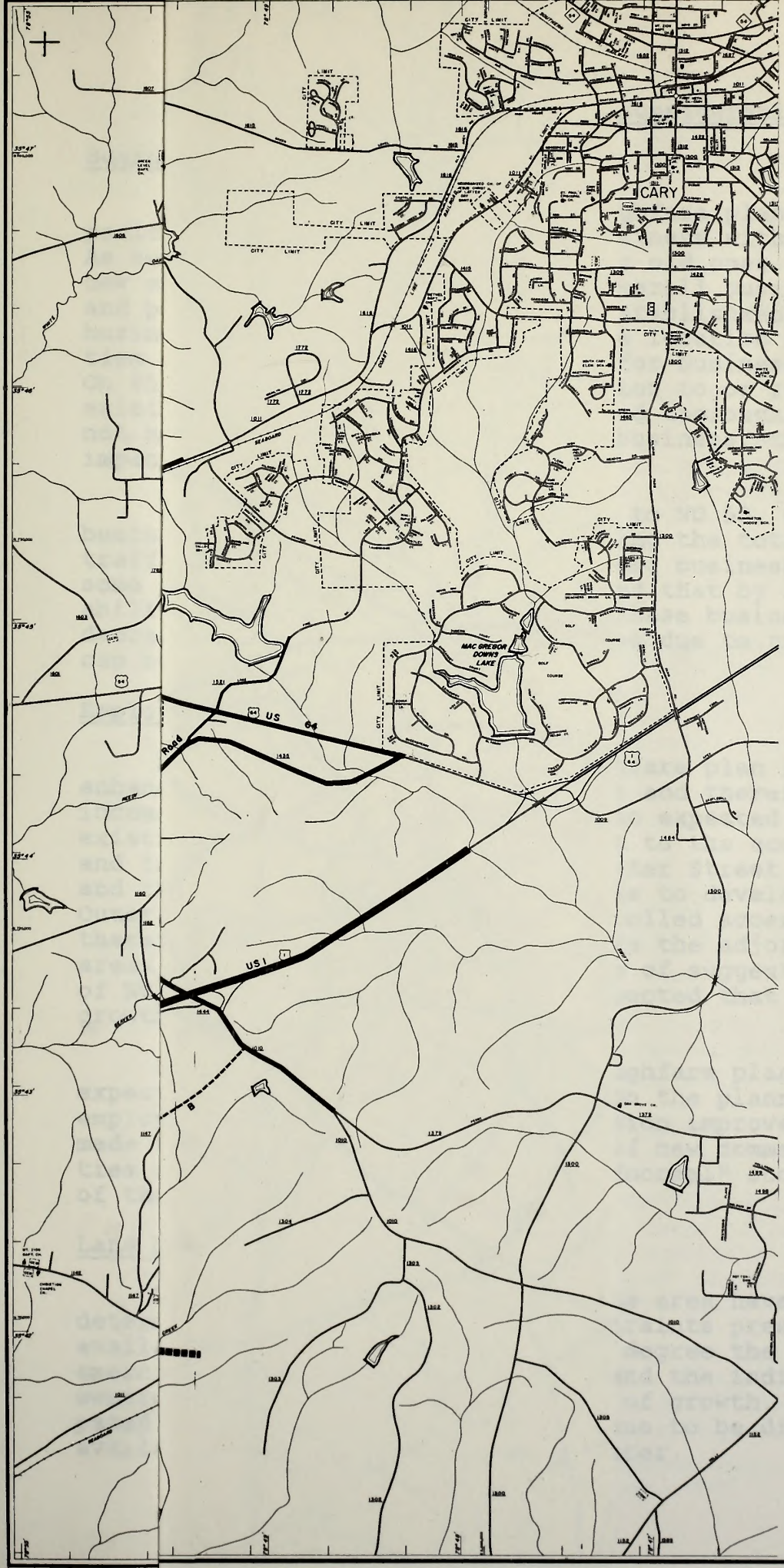
	EXISTING	PROPOSED
MAJOR	▬	▬
MINOR	—	- - -

N

S

APEX

FIGURE 9



RECOMMENDED THOROUGHFARE PLAN

APEX

N

S

Adopted By:

Town Of Apex _____

Recommended Approval By Planning And Research Branch _____

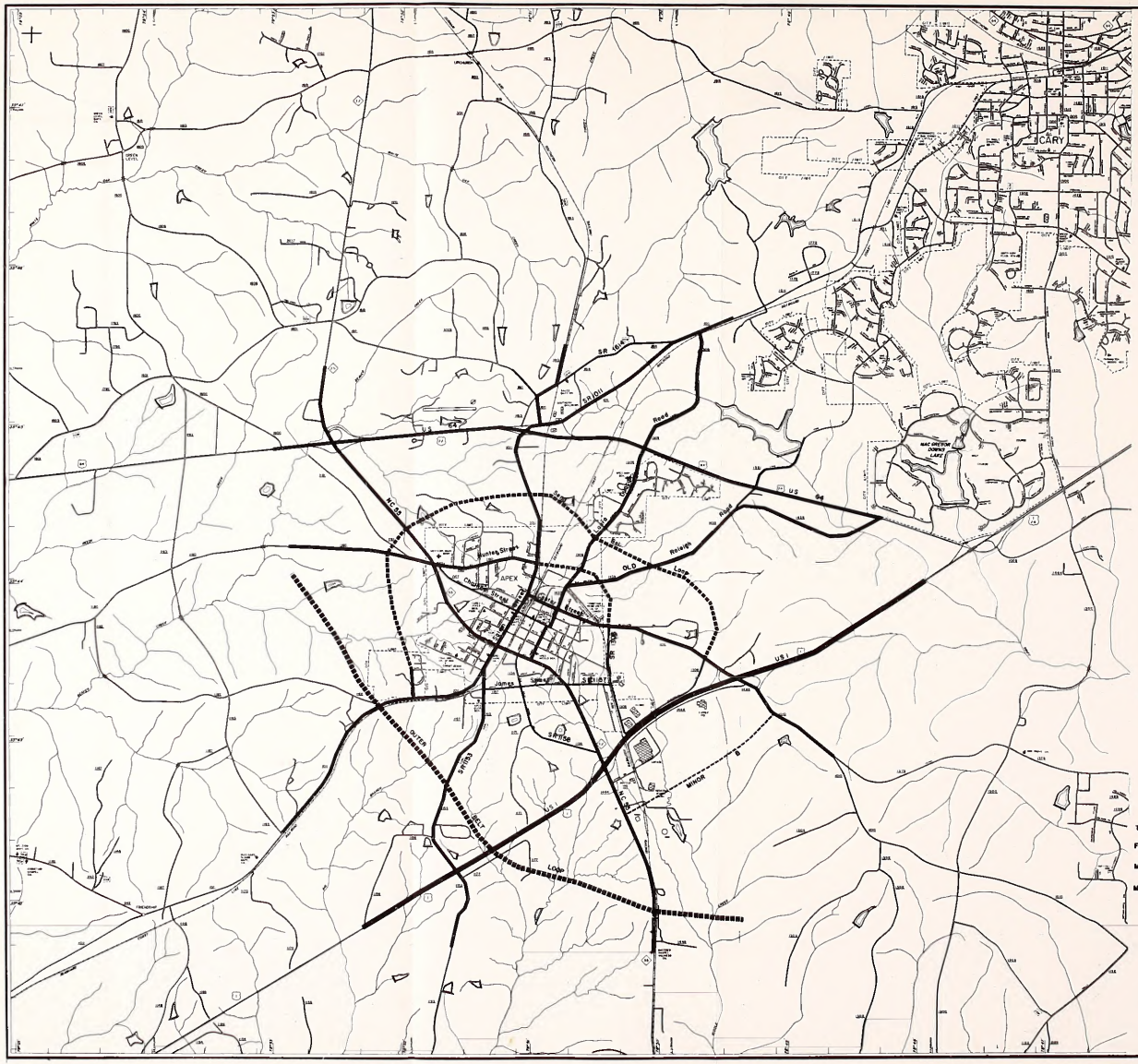
Adopted By Division Of Highways, North Carolina Department Of Transportation _____

-LEGEND-

THOROUGHFARES

	EXISTING	PROPOSED
FREEWAYS	▬▬	▮▮▮▮▮
MAJOR	▬▬	▬▬▬
MINOR	▬▬	▬▬▬

FIGURE 10



RECOMMENDED
THOROUGHFARE PLAN

APEX

N
S

Adopted By:

Town Of Apex _____

Recommended Approval By Planning And Research Branch _____

Adopted By Division Of Highways, North Carolina Department Of Transportation _____

-LEGEND-

THOROUGHFARES

	EXISTING	PROPOSED
FREEWAYS		
MAJOR		
MINOR		

FIGURE 10

Economic Environmental Considerations

Business

The implementation of a thoroughfare plan has both positive and negative affects on business within the area. As new facilities are constructed or old ones widened the new mobility tends to improve the overall business climate and proves more attractive to the establishment of new business interests. In addition the location of new facilities often opens up new land areas for business expansion. On the negative side is the disruption to or removal of existing businesses. As the proposed thoroughfare plan will not necessitate the removal of any business, the overall impacts should be positive.

Any negative impacts should be to NC 55, where several businesses are located. By decreasing the total volume of traffic on the existing highway, these businesses may lose some "impulse" business. It is hoped that by improving the ability of local shoppers to visit these businesses due to decreased congestion, that any losses due to traffic diversion can be offset.

Employment and Income

The development of the thoroughfare plan is expected to enhance the employment opportunities and therefore the income of an area. Since there is no expected disruption to existing businesses, any improvement to the access of shopping and industry will be a benefit. Hunter Street extension, and the semi-loop will open new areas to development. The Outer Loop is expected to be a controlled access highway and therefore will not provide service to the adjoining land areas; however with the construction of suggested interchanges of NC 55, US 1, and US 64, it is expected that commercial growth may occur along that route.

Failure to implement the thoroughfare plan would be expected to have a negative impact on the planning area's employment. When needed transportation improvements are not made this inhibits the development of new commercial facilities and can be a restraint on the "normal" economic expansion of the area.

Land Development Patterns

Land development patterns in the area have been largely determined by the geographical constraints present and the availability of water. To a lesser degree the control exercised by the local communities and the individual property owners has influenced the direction of growth. It is anticipated that future growth will continue to be directed by the availability of suitable land and water.

Much of the current growth is along the existing radials Laura Duncan Rd., Raleigh Rd., SR 1010 and US 1 that bisect the areas of land with the greatest growth potential. One of the major goals of any planned development is the provision of loop roads that allow for the development of the land between these radials. The proposed outer loop, the semi-loop, and Hunter St. Extension will all act as loop roads.

Public Utilities

Improvements recommended by each plan will necessarily cause the relocation of public utilities located adjacent to the roadway. A relative measure of each alternative thoroughfare plan's effect on public utilities can be obtained by comparing the miles of widening required under each of the plans. Construction on new locations will cause some utilities to relocate but not as extensively as widening projects. Utilities relocation costs have not been included in the right of way estimates for Plan D (the recommended plan).

It is recommended that any utilities' lines which must be adjusted or relocated be shown on the individual project plans. Utility company representatives and/or other officials responsible for these utilities should be contacted in order to implement relocation procedures. Adjustment and relocation should be completed insofar as possible, prior to beginning project construction. This procedure will minimize or eliminate potential disruption of utility service.

Design Requirements

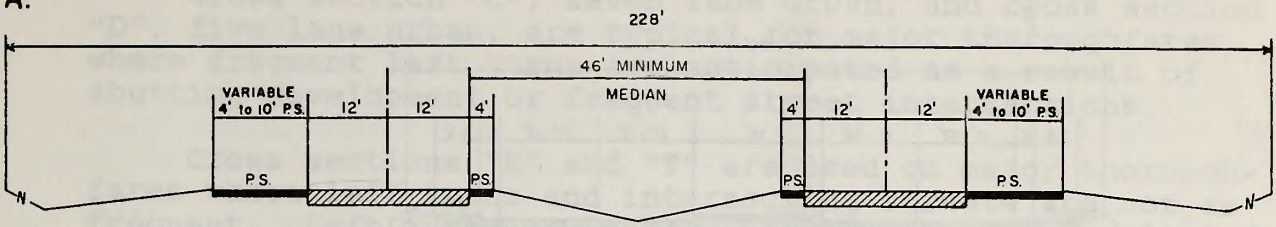
Design requirements for thoroughfares vary according to the desired capacity and level of services to be provided. Universal standards in the design of thoroughfares are not practical. Each street section must be individually analyzed and its design requirements determined on the basis of amount and type of service, and available right-of-way.

Typical cross section recommendations are shown in Figure 11. Cross section "A" is typical for controlled access freeways. The 46 foot grassed median is the minimum desirable median width, but there could be some variation from this depending upon design considerations. Slopes of 8:1 into 3 foot drainage ditches are desirable for traffic safety. Right-of-way requirements would typically vary upward from 228 feet depending upon cut and fill requirements.

Cross section "B" is typical for four lane divided highway in rural areas which may have only partial or no control of access. The minimum median width for this cross section is 30 feet, but a wider median is desirable. Design

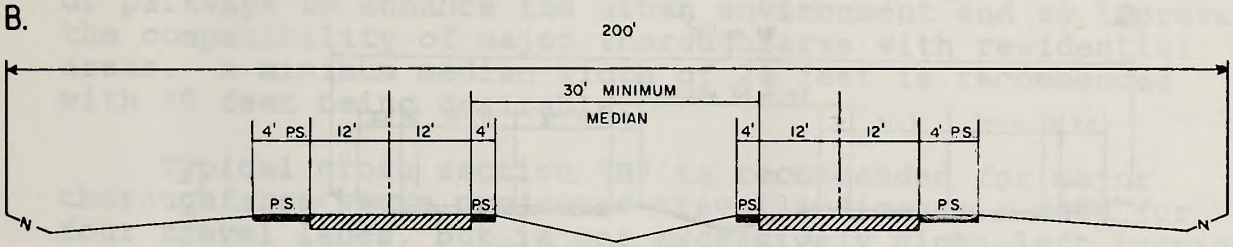
TYPICAL THOROUGHFARE CROSS SECTIONS

A.



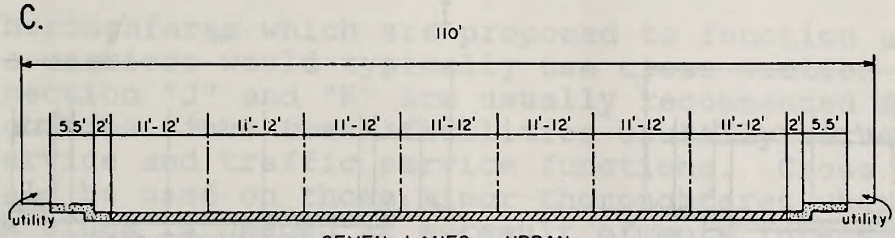
FOUR LANES DIVIDED WITH MEDIAN - FREEWAY

B.



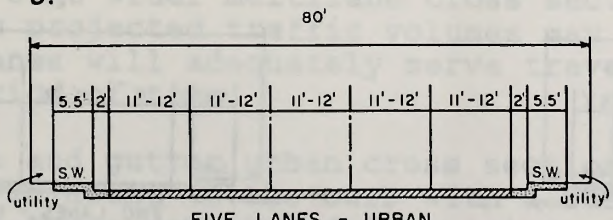
FOUR LANES DIVIDED WITH MEDIAN - RURAL

C.



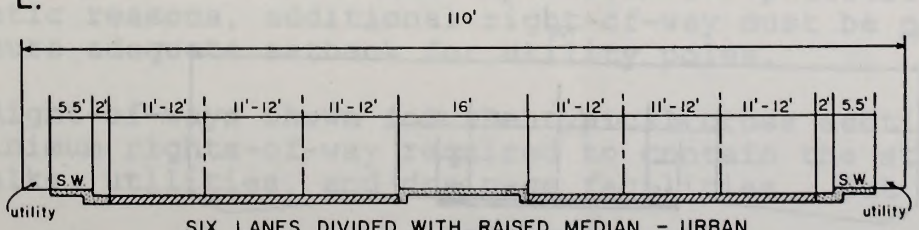
SEVEN LANES - URBAN

D.



FIVE LANES - URBAN

E.

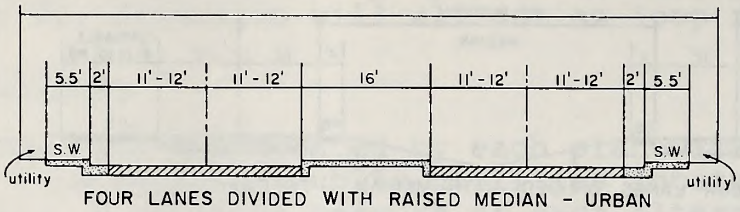


SIX LANES DIVIDED WITH RAISED MEDIAN - URBAN

FIGURE 11

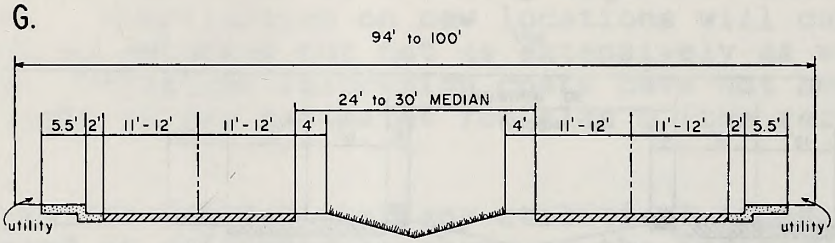
TYPICAL THOROUGHFARE CROSS SECTIONS
(CONTINUED)

F.



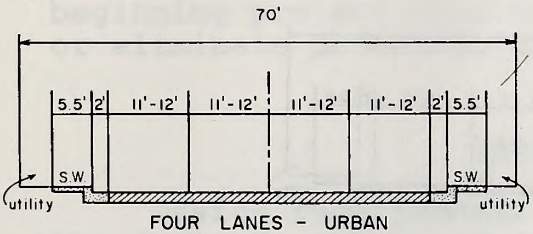
FOUR LANES DIVIDED WITH RAISED MEDIAN - URBAN

G.



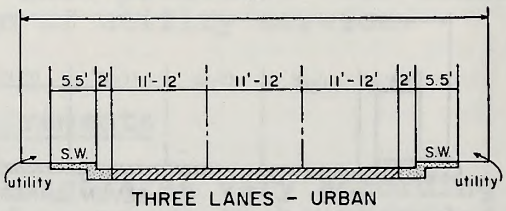
FOUR LANES DIVIDED - URBAN BOULEVARD
GRASS MEDIAN

H.



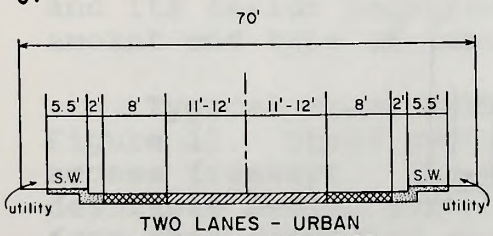
FOUR LANES - URBAN

I.



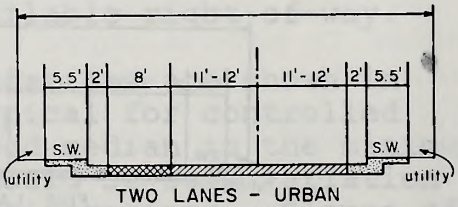
THREE LANES - URBAN

J.



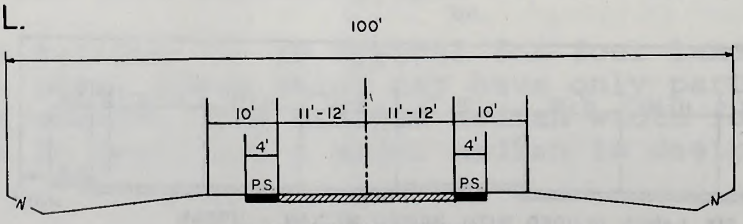
TWO LANES - URBAN
PARKING ON EACH SIDE

K.



TWO LANES - URBAN
PARKING ON ONE SIDE

L.



TWO LANES - RURAL

requirements for slopes and drainage would be similar to cross section "A", but there may be some variation from this depending upon right-of-way constraints.

Cross section "C", seven lane urban, and cross section "D", five lane urban, are typical for major thoroughfares where frequent left turns are anticipated as a result of abutting development or frequent street intersections.

Cross sections "E" and "F" are used on major thoroughfares where left turns and intersecting streets are not as frequent. Left turns would be restricted to a few selected intersections.

Cross section "G" is recommended for urban boulevards or parkways to enhance the urban environment and to improve the compatibility of major thoroughfares with residential areas. A minimum median width of 24 feet is recommended with 30 feet being desirable.

Typical cross section "H" is recommended for major thoroughfares where projected travel indicates a need for four travel lanes, but is not excessively high; left turning movements are light; and right-of-way is restricted. An additional left turn lane would probably be required at major intersections.

Thoroughfares which are proposed to function as one-way traffic carriers would typically use cross section "I". Cross section "J" and "K" are usually recommended for minor thoroughfares since these facilities ususally serve both land service and traffic service functions. Cross section "J" would be used on those minor thoroughfares where parking on both sides is needed as a result of more intense development.

Cross section "L" is used in rural areas or for staged construction of a wider multilane cross section. On some thoroughfares projected traffic volumes may indicate that two travel lanes will adequately serve travel for a considerable period of time.

The curb and gutter urban cross sections all illustrate the sidewalk adjacent to the curb with a buffer or utility strip between the sidewalk and the minimum right-of-way line. This permits adequate setback for utility poles. If it is desired to move the sidewalk further away from the street to provide additional separation for pedestrians for aesthetic reasons, additional right-of-way must be provided to insure adequate setback for utility poles.

Right-of-ways shown for the typical cross sections are the minimum rights-of-way required to contain the street, sidewalks, utilities, and drainage facilities. Cut and fill

requirements may require either additional right-of-way or construction easements. Obtaining construction easements is becoming the more common practice for urban thoroughfare construction.

If there is sufficient bicycle travel along the thoroughfare to justify a bicycle lane or bikeway, additional right-of-way may be required to contain the bicycle facilities. The North Carolina Bicycle Facility and Program Handbook[4] should be consulted for design standards for bicycle facilities.

Recommended design standards relating to maximum and minimum grades, minimum sight distances, maximum degree of curve and related superelavation, and other considerations for thoroughfares are given in Appendix C. This Appendix gives definitions and design standards recommended for inclusion in subdivision regulations.

---

[4]The North Carolina Bicycle Facility and Program Handbook, Barton-Aschman Associates, Inc., April, 1975.

V. RECOMMENDATIONS

The Proposed Thoroughfare Plan

The recommended thoroughfare plan resulting from the study and analysis is Alternate D shown in Figure 10. The function of each thoroughfare along with the appropriate system classification, and recommended improvements are given below:

Radial and Crosstown Streets

1. NC 55 (Williams Street) serves as a major north-south radial through Apex with direct access to the CBD. This facility extends north into Durham and south into Southern Wake County.

2. Salem Street extends north and south and is the center of the CBD. It is the major north-south cross-town facility.

3. Hunter Street provides radial street movement between Salem Street, NC 55 and western areas of Apex and Wake County.

4. Laura Duncan Rd. acts as a northeastern radial from Cary to Center Street.

5. Old Raleigh Rd. provides eastern radial service from US 64 into the downtown area.

6. Center Street carries southeastern traffic from US 1 to the Apex CBD.

7. SR 1153 extends southernly into Wake County and serves as a radial into Salem Street.

Loop System

1. Hunter Street Extension serves as an inner loop in the northeast quadrant of Apex from McCullers Rd. to Salem Street.

2. Proposed Outer Loop from South Salem Street to McCullers Rd. (SR 1010). This facility will aid the inner loop, Crosstown Street and Salem Street in the western, northern, and eastern areas and will carry less local oriented traffic from industrial, residential, commercial, emergency medical and recreational facilities.

Bypass

1. US 64 allows for east-west flow of traffic north of Apex.

2. US 1 provides for northeast and southwest movement south of the central area.

3. Proposed Outer Belt Loop in the vicinity of Apex is a part of the outer loop around the Raleigh-Cary-Garner Urbanized Area. The portion around Apex will function as a bypass for NC 55 traffic as well as a freeway facility for the Raleigh-Cary-Garner Areas.

Minor Thoroughfares

1. Chatham Street (SR 1307)

2. James Street (SR 1157)

3. Old Holly Springs Rd. (SR 1158)

4. Barnhill Rd. (SR 1306)

5. SR 1614

6. Old Raleigh Rd. Connector

7. Schefflin Rd. (SR 1306)

8. SR 1611

9. NC 55 and SR 1010 Connector

Construction Priorities and Cost Estimates

The establishment of project construction priorities is one of the most important and controversial outcomes of thoroughfare planning. The general goals and objectives of a group or individual can dramatically alter the order of a priority listing. A more quantitative and less opinionated approach is to establish priorities based on traffic congestion (often referred to as the volume to capacity ratio). A preferred and more comprehensive approach is to use benefit/cost ratios. Costs and benefits that can be used in this approach are listed below:

1. initial construction costs

2. right of way costs

3. road maintenance costs

4. accident costs

5. fuel cost

6. auto cost, depreciation and maintenance

7. driving time

Priorities for Apex were based on a combination of these three approaches. Several projects are included in each priority rank to allow for some flexibility when estimates deviate from future realities. The recommended priorities given in Table 7 and shown in Figure 12 do not attempt to dictate an order of implementation, but merely suggest a priority based on the results of this study.

Construction and right of way costs are in 1980 dollars and are based on preliminary estimates made by the project engineer.

First Priority

These projects are included in the first priority grouping of project. Included are (1) US 64 widening, (2) NC 55 widening, and (3) Hunter Street Extension.

US 64 is the major east-west facility located in the northern section of the planning area. This highway carries over 50% of through traffic into Cary and Raleigh from the east end and Sanford end vicinity to the west. The recreational facilities of the new Jordan Reservoir will entice additional traffic on this corridor. Widening of US 64 to a four-lane facility will provide the additional capacity to handle future traffic.

NC 55 is the major north-south radial into and through Apex and the most congested of the highways in the area. Widening to a four lane section will provide the needed future capacity and also provide turning lanes at major intersections.

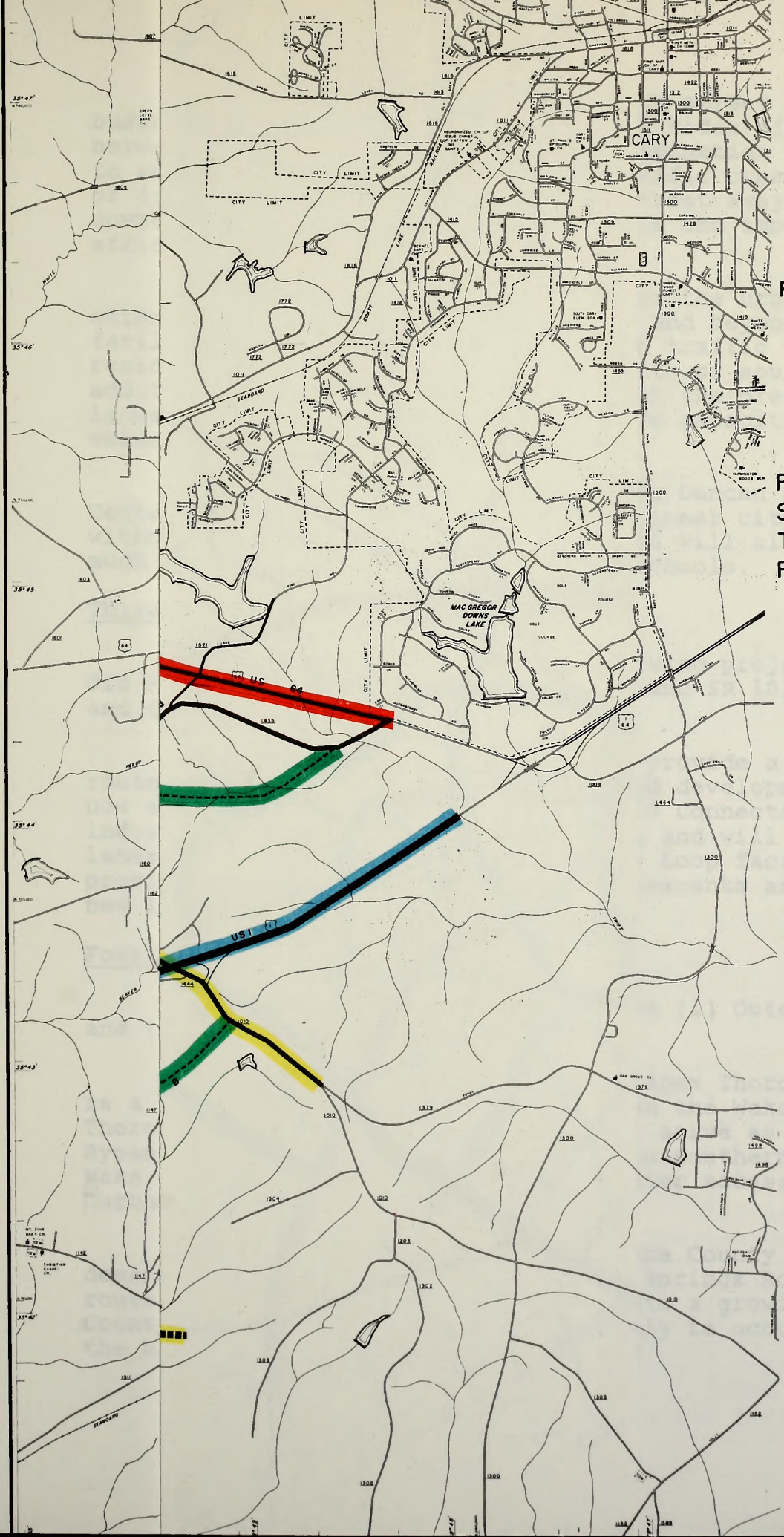
Hunter Street Extension between Laura Duncan Rd. and Salem Street is listed as a first priority project because of an inner city need of an east-west street. This extension is desirable because of the High School location and the inability of inner city movement.

Second Priority

Projects in the second priority include (1) Salem Street, (2) US 1, and (3) Hunter Extension.

TABLE 7

Construction Priorities and Cost Estimates				
Project	Recommended Cross Section	Construction Cost ($1000)	Right of Way Cost ($1000)	Total Cost (1000)
First Priority				
1 US 64 Widening	H	1,800	-	1,800
2. NC 55 Widening	H	1,900	575	2,475
3. Hunter Street Extension (Salem Street to Laura Duncan Rd.)	J	210	100	310
Second Priority				
1. Salem Street Widening	H	1,280	-	1,280
2. US 1 Widening	A	3,500	-	3,500
3. Hunter Street Extension (Laura Duncan Road to Center Street)	J	320	175	495
Third Priority				
1. Old Raleigh Road Connector	K	750	285	1,035
2. NC 55 and SR 1010 Connector	J	890	225	1,115
3. Inner Loop Facility	J	2,400	845	3,245
Fourth Priority				
1. Outer Belt Loop	A		4,800	
2. Holly Springs Road Widening		760	-	760



ALTERNATIVE PLAN D

PROPOSED CONSTRUCTION PRIORITIES

LEGEND

FIRST PRIORITY
SECOND PRIORITY
THIRD PRIORITY
FOURTH PRIORITY

RECOMMENDED THOROUGHFARE PLAN

APEX

N
S

Adopted By:

Town Of Apex _____

Recommended Approval By Planning And Research Branch _____

Adopted By Division Of Highways, North Carolina Department Of Transportation _____

-LEGEND-

THOROUGHFARES

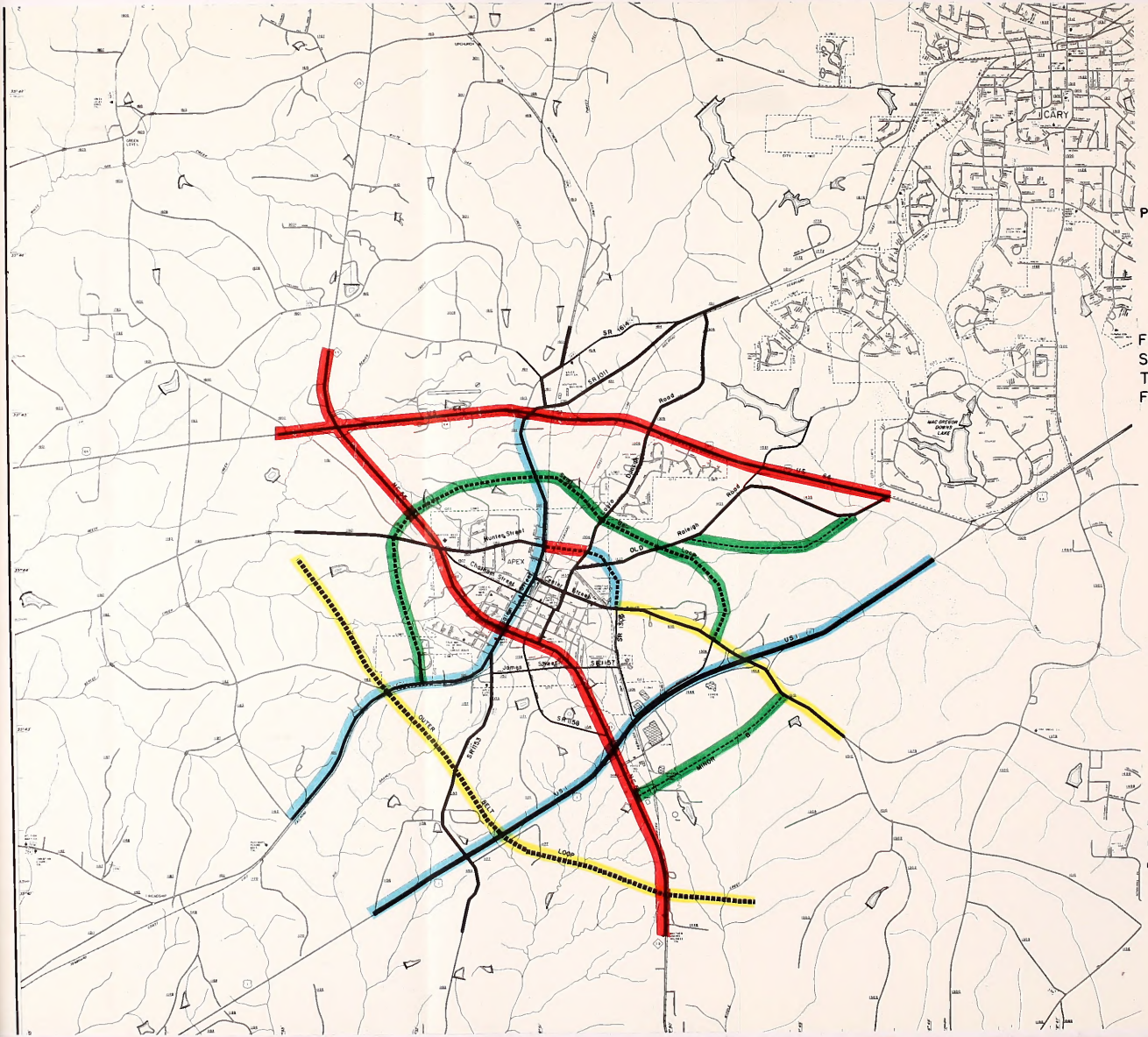
	EXISTING	PROPOSED
FREEWAYS	▬▬▬	▪▪▪▪▪
MAJOR	▬▬▬	▪▪▪▪▪
MINOR	▬▬▬	------

FIGURE 12

TABLE 7

Construction Priorities and Cost Estimates

Project	Recommended Cross Section	Construction Cost ($1000)	Right of Way Cost ($1000)	Total Cost (1000)
First Priority				
1 US 64 Widening	H	1,800	-	1,800
2. NC 55 Widening	H	1,900	575	2,475
3. Hunter Street Extension (Salem Street to Laura Duncan Rd.)	J	210	100	310
Second Priority				
1. Salem Street Widening	H	1,280	-	1,280
2. US 1 Widening	A	3,500	-	3,500
3. Hunter Street Extension (Laura Duncan Road to Center Street)	J	320	175	495
Third Priority				
1. Old Raleigh Road Connector	K	750	285	1,035
2. NC 55 and SR 1010 Connector	J	890	225	1,115
3. Inner Loop Facility	J	2,400	845	3,245
Fourth Priority				
1. Outer Belt Loop	A		4,800	
2. Holly Springs Road Widening		760	-	760



ALTERNATIVE
PLAN
D

PROPOSED CONSTRUCTION
PRIORITIES

LEGEND

FIRST PRIORITY
SECOND PRIORITY
THIRD PRIORITY
FOURTH PRIORITY

RECOMMENDED
THOROUGHFARE PLAN

APEX

N
S

Adopted By:

Town Of Apex _____

Recommended Approval By Planning And Research Branch _____

Adopted By Division Of Highways, North Carolina Department Of Transportation _____

-LEGEND-

THOROUGHFARES	EXISTING	PROPOSED
FREEWAYS	▬▬	▬▬
MAJOR	▬	▬
MINOR	—	- - - -

FIGURE 12

Salem Street is the major downtown street in the central business district with parking on both sides of the street between Center and Moore Streets. Elimination of the parking to adjacent lots will increase the traffic crossing capability of Salem Street. Widening of Salem Street away from the downtown will enhance the downtown look and improve traffic efficiency in the area.

US 1 is the major highway south of the urbanized area attending from Raleigh toward Sanford and beyond. This facility carries a majority of through traffic with local residents using the facility going north or south. An additional two lanes that conforms with the present four lanes north of US 1 and 64 will provide capacity for future volumes.

Hunter Street Extension from Laura Duncan Road to Center Street will provide for better inner city movements without entering the shopping area. It will also provide much needed access to and from local schools.

Third Priority

Third priority includes the following projects: (1) Old Raleigh Road Connector, (2) NC 55 and SR 1010 Connector, and (3) Inner Loop Facility.

Old Raleigh Road Connection will provide a more direct route into Apex and serve abutting land development occurring now and in the future NC 55 and SR 1010 Connector will serve industrial development already present and will open up new lands for industrial sites. The Inner Loop facility will provide for efficient local traffic movements and will open new lands to residential development.

Fourth Priority

Included under fourth priority are (1) Outer Belt Loop, and (2) Holly Springs Road widening.

The Outer Belt Loop shown on the Apex Thoroughfare Plan is a portion of the Outer Loop shown on the Wake County Thoroughfare Plan. This facility will serve as the NC 55 Bypass around Apex serving northern and southern portions of Wake County and also will provide greater access to Raleigh-Durham Airport.

Increasing volumes in southern Wake County creates the demand for widening of SR 1010 (Holly Springs Road). This route is a major southeastern route into a growing Wake County area. More development is likely to occur because of the Raleigh Beltline completion nearby.

Traffic Operations

Traffic operations is concerned with making the most effective utilization of a given street system. The application of such methods as one-way street operations, coordination of traffic control devices, separate turn lane provisions at intersections, channelization of intersection approaches, removal of on-street parking near intersections and other traffic control measures, can substantially increase the capacity of a street or street system.

From the above paragraph, it is evident that intersection capacity is the major factor relating to the capacity of a given facility. Due to conflicting traffic movements, intersections are also the sites where most accidents occur. The type of traffic control device used at any particular intersection is dependent on traffic and safety warrants at that intersection and may vary from a simple stop sign at minor intersections to an intricate signal system at a major intersection.

Much of the effectiveness of the Recommended Apex Thoroughfare Plan will rely on the operational efficiency of major intersections and the signalization system. Poor timing and coordination of a signal system can be a major contributor to congestion on an otherwise adequate system.

The following policies are suggested as guidelines to be followed in the development of the thoroughfare plan:

1) All intersections should have some type of control.

2) Four-way stop signs should not be utilized at any intersection.

3) Stop and yield signs should be used on local streets in such a manner so as to discourage through traffic.

4) Major intersections should have traffic control devices consistent with actual traffic demands according to accepted signalization warrants.

5) Signals at major street intersections should be phased to allow maximum movement through the intersection. The recommended minimum cycle length is 60 seconds. (Note: As a result of a 1964-65 inventory of traffic control devices on the State Highway System performed by consultants employed by the Division of Highways, the traffic control devices on the State Highway System are in the process of being upgraded to meet the standards of the Manual On Uniform Traffic Control Devices For Streets and Highways)[5]

6) Signals along major traffic corridors should be interconnected to facilitate maximum progression at reasonable speeds along said corridors.

7) Use of special cycle phases (i. e. exclusive pedestrian movements, left turns, etc.) should be minimized.

8) Parking should be prohibited for 30 feet in advance of each intersection and for 20 feet in advance of each crosswalk.

9) Stop signs should be placed at all minor street intersections with major streets, where signals are not warranted.

10) All traffic control devices should be installed and standarized in accordance with the Manual on Uniform Traffic Control Devices.[5]

Transit

Apex is characteristic of many small towns in that it does not possess the population size or density to support a conventional bus or fixed route transit system without heavy subsidies. Most new residential development is expected to be low density in nature, which is not conducive to transit operations.

Internally, no local public transit system exists, although some jitany or van pool service is available for the elderly and handicapped sponsored by Wake County Social Services. The Capitol Area Transit System of Raleigh operates a bus commuter service from several areas in the count. Possibilities of extending bus commuter service to Apex is a more realistic approach to transit service for the Apex area.

Parking

A 1978 inventory of parking in the Apex CBD indicated a total of 311 available spaces. There are 226 private spaces and 85 public spaces. Also, there are numerous unmarked open areas where public parking is permitted.

---

[5] Manual on Uniform Traffic Control Devices for Streets and Highways (Prepared by the National Joint Committee on Uniform Traffic Control Devices, Washington, D. C.: U. S. Department of Transportation, Federal Highway Administration, 1978).

To determine parking demands for 2000 and 2005, an analysis was made using a procedure documented by Wilbur Smith and Associates. A parking space factor (P) is multiplied by the daily auto destination into the CBD. The parking space factor is best stated by the formula:[6]

$$P = \frac{drsc}{oe}$$

Where,

P = Parking space factor
d = daytime CBD travel factor = .70 (assumed)
o = occupancy in persons per vehicle (for auto trip ends = 1.0)
e = efficiency of space use = .85 (assumed)
r = ratio of peak to total daytime parkers = .2 (assumed)
s = seasonal peaking factor
c = locational adjustment factor to reflect concentration of demands in the core area

Note: When data for all factors is not known, the minimum demand level assumes s and c equal to 1.0

Substituting into the previous equation yields

$$P = \frac{(.70)(.2)(1.0)(1.)}{(1.0)(.85)} = .165$$

There were approximately 1000 auto trips each day into the CBD in 1978. There was a demand for (.165)(1000) = 165 parking spaces in 1978. This left Apex with a surplus of 146 spaces. It is predicted that the demand for parking in 2000 and 2005 will not change significantly from the 1978 demand because of the declining growth rate of the CBD.

Bicycles

There are currently no roads in the planning area listed in North Carolina Bicycling Highways.[7] However, there has been interest expressed by citizens of the area in

---

[6] Parking in the City Center, Wilbur Smith and Associates, New Haven, Connecticut, 1965, p. 22.

[7] North Carolina Department of Transportation, Systems Planning Unit, North Carolina Bicycling Highways, 1976.

the provision of bikeways. Even though the amount of travel service alone may not justify major expenditures in this area, there are other justifications which may be applied.

The value of bicycling as a healthful means of exercise is well known. In addition, the mere opportunity to ride a bicycle because a person may feel like it has some value in our society. Preserving the environment and conserving energy resources are very popular current arguments in support of expenditures for bicycle facilities. Bicycling causes almost no air or noise pollution in comparison to the automobile, but to date there is little evidence that bicycling has had any substantial impact on the use of automobiles. While the bicycle has some potential for pedestrian interference, increased safety problems, and interruption of natural areas, it can generally be said that the bicycle has less potential for environmental destruction than most other forms of transportation.

In general, in determining funding for bicycle facilities the amount of expenditures should be considered in terms of their relationship to expenditures on other forms of recreation, transportation and transportation safety.

Assistance in funding bicycle programs can be obtained from many sources. Through several Federal aid assistance programs from 50 to 100 percent of capital expenditures can be obtained. Sources of funds include Land and Water Conservation Funds (Bureau of Outdoor Recreation), Federal Aid Highway Funds, Federal Highway Safety Funds, Housing Aid Highway Funds, Federal Highway Safety Funds, Housing and Community Development Funds, and General Revenue Sharing. Design criteria, implementation procedures, and further funding information can be found in <u>The North Carolina Bicycle Facility and Program Handbook</u>.

VI. IMPLEMENTATION

There are several tools which are available for implementation of the thoroughfare plan. They are as follows:

State and Municipal Adoption of the Thoroughfare Plan

Chapter 136, Article 3A, Section 136-66.2 of the General Statutes of North Carolina provides that after development of a thoroughfare plan, the plan may be adopted by the governing body of the municipality and the Board of Transportation as the basis for future street and highway improvements. After mutual adoption, negotiations will begin to determine which of the existing and proposed thoroughfares will be a Board of Transportation responsibility and which will be a municipal responsibility. Facilities which are designated a State responsibility will be constructed and maintained by the Division of Highways; however, the municipality will share in the right-of-way costs with the municipality's share of the cost to be determined at time of construction.

Chapter 136, Article 3A, Section 136-66.1 of the General Statutes provides guidance in the delineation of responsibilities. In summary, these statutes provide that the Department of Transportation shall be responsible for those facilities which serve volumes of through traffic and traffic from outside the area to major business, industrial, governmental and institutional destination located inside the municipality. The municipality is responsible for those facilities which serve primarily internal travel.

Apex's existing 1964 thoroughfare plan was revised by the Town in 1976. The plan has been revised recently by the Town and the Department of Transportation and is expected to be approved in the near future. Agreement on street and highway system responsibilities has not been approved.

Subdivision Control

A subdivision ordinance requires that every subdivider submit to the Town Planning Commission a plot of his proposed subdivision. Certain standards must be met by the developer before he can be issued a building permit to construct his development. Through this process, it is possible to reserve or protect the necessary rights of way for projected streets which are a part of the thoroughfare plan and to require street construction in accordance with the plan.

Facilities which could be implemented or partially implemented by subdivision control include:

1. Old Raleigh Road Connector
2. Inner Loop
3. NC 55 and SR 1010 Connector

Official Street Map

A municipality may, through special enabling legislation, adopt an official street map which indicates both existing and future street lines. No new construction or reconstruction of structures would be permitted within the designated future street lines. This would, over a period of time, reduce the cost of additional right of way along densely developed thoroughfares which will require widening at some future date.

Future street lines should be established to provide for the ultimate right of way specified in Appendix B.

Zoning

A zoning ordinance can be beneficial to thoroughfare planning in that planned locations of various land uses and planned densities of dwellings can be realized. This provides a degree of stability on which to make future traffic projections and to plan streets and highways.

Other benefits of a good zoning ordinance are: (1) the establishment of standards of development which will aid traffic operations on major thoroughfares, and (2) the minimization of strip commercial development which creates traffic friction and increases the traffic accident potential.

The zoning ordinance should be structured to control strip development along the major traffic-carrying thoroughfares. There are several major streets on the existing system that have experienced a decreased traffic-carrying capacity due to strip development. Necessary efforts should be maintained to retard strip development and thereby protect the traffic-carrying capability of major thoroughfares.

Urban Renewal

Urban renewal is the term used to describe the removal of slums and allows for corrections to basic problems in the street system layout and design.

To qualify for community development funds or discretionary funds, a city must first prepare a community development program. Urban areas compete throughout the state on the bases of demographic points which consider such conditions as percent of substandard housing, people per square feet of housing, dwelling age etc.

An effort should be made to ensure that community development and transportation plans are compatible.

Capital Improvements Program

One of the tools which makes it easier to build a planned thoroughfare system is a capital improvements program. This is a long range plan for the spending of money on street improvements, acquisition of rights-of-way, and other capital improvements within the bounds of projected revenues. Municipal funds should be available for construction of street improvements which are a municipal responsibility, right of way cost sharing on facilities designated a Division of Highways responsibility, and advance purchase of right of way where such action is required.

The section of the capital improvements program which deals with the thoroughfare plan requires a fairly detailed knowledge of the costs of various projects. Therefore, the cost estimates included in this report should be used with caution since they are preliminary estimates based on general statewide averages of construction costs and "windshield" estimates of right of way costs.

APPENDIX A

TRAVEL FORECAST MODELS

BASE YEAR TRAVEL DESIRES

The Raleigh trip generation rates were used to calculate generation rates for Apex since the Town is in close proximity to the Raleigh urbanized area with characteristics similar to Cary and Garner. From the original Raleigh-Cary-Garner Origin and Destination Survey, dwelling units were categorized into white and non-white and also into high, medium, and low of each group.

The Apex income groups were then divided into three groups to correspond to the high, medium, and low of the Origin and Destination Surveys. The cross-class Raleigh curves were then interpolated between income and dwelling units of 2, 3, and 4 persons. The medium and high income group were further interpolated between the high incomes of Raleigh data based on the finding of the census tract data that the median income for Raleigh was greater than the remaining portions of Wake County. The median income was adjusted based on income groupings to correspond to the median income of Wake County. Median income for the City of Raleigh for 1970 was $10,400 with Apex being $8,935.

The number of dwelling units of high, medium, and low were multiplied by the income data of same sequence and then divided by total number of dwelling units to determine median income. This data is shown below in Table A-1.

TABLE A-1

Total Income of Dwelling Units			
	D.U.'s	Income	Total Income
High	275	4,000	1,100,000
Medium	733	9,000	6,597,000
Low	228	17,500	3,990,000
Totals	1236	*9,455	11,687,000

*Median Income

Based on the above data, the matrix was adjusted to reflect the median income of the Apex census tract. The generation rates were then applied to the Internal Data Summary Program in order to generate trip productions. These rates are shown in Tables 2 and 3 below.

TABLE A-2

Trip Generation Rates by Median Income and Person/Dwelling Unit			
Trip Purpose[a]	Income Levels		
	High	Medium	Low
	$16,500	$8,500	$4,000
HBW	1.53	1.20	.69
HBS	1.08	.86	.43
NHB	2.71	1.45	.55
OHB	3.45	2.50	1.58
Totals[b]	8.77	6.01	3.25

[a]HBW-Home Based Work, HBS-Home Base Shop
NHB-None Home Based, OHB-Other Home Base

[b]Average area wide trip rate = 5.9

TABLE A-3

Study Area Constants			
	OCC/DUS	x #/D.U.'s	= Population
High	2.9	227	658
Medium	3.0	615	1845
Low	3.2	83	266
High	3.2	1	3
Medium	3.5	118	413
Low	4.0	192	768
Av.	3.2	1236	3953

It should be noted that the average generation rate for Apex was 5.9 trips/DU compared to the Raleigh area wide

average of 8.2 trips/DU. The difference in average rate can be explained by the large difference in income levels for the two areas.

1978 Internal Trips

The data that forms the basis of a thoroughfare planning study is usually collected from an origin and destination survey. For the Apex study, there was an external origin and destination survey conducted in 1978, but no internal survey was done. In order to obtain internal data, the internal travel patterns were synthesized involving the following process:

(1) Determination of zonal trip productions using generation rates developed from the Raleigh-Cary-Garner area cross-classification curves.

(2) Determination of zonal attraction factors by utilizing multiple regression analysis, a common statistical technique.

(3) Determination of trip distribution utilizing a three purpose gravity model using trip length frequency curves developed in a similar urban area.

Trip Productions: Average daily trip productions were estimated on a zonal basis in units; (2) trips produced by commercial trucks; and (3) trips produced by commercial passenger vehicles. Dwelling unit trip generation rates were developed from the Raleigh-Cary-Garner cross-classification curves by using person per dwelling unit and median income per zone. These generation units are given in Tables A-2 and A-3.

The trip generation rate for trucks was obtained from home interviews conducted in Wilson, N. C., and was estimated to be 6.7 vehicle trips per day. Commercially owned passenger vehicles were also estimated to make 6.7 trips per vehicle per day on the assumption that they would have trip generation rates similar to trucks.

Trip Attractions: Trip attractions for the 35 zones in the planning area were considered to be related to employment characteristics. HBW trip attraction factors were taken to be the total employment within the zone as shown in Table A-.4 Factors for OHB and NHB trips were based on employment figures were used as the independent variable in a multiple regression analysis. The dependent variable consisted of the external trip ends inside the planning area as observed during the external origin and destination survey.

TABLE A-4

1978 EMPLOYMENT DATA BY ZONE AND TYPE

ZONE	INDUSTRIAL	RETAIL & WHOLESALE	HIGHWAY RETAIL	OFFICE	SERVICE	TOTAL
1	24	94	0	76	100	0
2	0	50	0	0	0	50
3	0	145	5	0	100	40
4	0	0	0	0	0	100
5	0	0	0	0	0	56
6	0	29	0	0	0	225
7	105	25	0	35	35	175
8	70	0	6	20	14	50
9	150	15	5	20	25	225
10	438	32	5	10	0	70
11	9	105	5	10	75	50
12	55	0	15	0	5	95
13		0	25	0	0	35
14	25	10	5	4	6	42
15	65	0	0	0	0	32
16	285	10	5	20	5	40
17	1975	0	5	10	10	0
18	364	0	0	26	10	29
19	75	30	0	50	20	225
20	103	5	5	10	5	100
21	50	0	0	0	0	90
22	0	0	0	0	0	225
23	85	45	0	5	10	55
24	0	6	8	8	6	0
25	0	0	0	53	0	70
26	0	0	0	0	49	28
27	0	50	5	5	0	39
28	85	40	10	0	0	50
29	30	30	10	40	20	20
30	100	10	5	5	5	25
31	0	40	5	0	10	22
32	0	0	0	0	5	59
33	0	0	0	0	0	110
34	0	0	0	0	0	20
35	0	0	0	0	0	20

The initial regression equation for estimating trip attraction factors was:

$$Y = a + bX_1 + cX_2 + dX_3 + eX_4 + fX_5 + gX_6$$

Where Y = zonal attraction factor
X_1 = zonal industrial employment
X_2 = zonal retail and wholesale employment
X_3 = zonal highway retail employment
X_4 = zonal office and institutional employment
X_5 = zonal service employment
X_6 = zonal dwelling units
a,b,c,d,e,f,g = constant determined by regression analysis

Preliminary analysis indicated that the independent variable X_3 did not significantly increase the prediction quality of the equation aid was therefore dropped in the final analysis.

The final regression equation used to calculate attraction factors for OHB and NHB trips was

$$Y = 52.04 + 2.38X_1 + 10.66X_2 + 19.26X_4 + 9.30X_5 + .91X_6$$

The attraction factors computed by this equation are included in Table A-5. In testing the significance of the equation, the coefficient of determination (R^2) was calculated to be .99. This is the proportion of the total variation explained by the regression equation. Multiple regression statistical date are given below in Table A-6.

Trip Distribution: The gravity model trip distribution program was used to distribute internal trips. Input to this program included: (1) a trip length frequency curve, (2) zonal attraction factors, (3) zonal trip productions, and (4) travel time between zone centroids. Table A-7, below gives the trip length frequency curves used in the Apex study.

1978 External and Through Trips

To inventory external and through trips, origin and destination traffic survey stations were established on a cordon line (see Figure 4) surrounding the survey area at each principal radial highway. In all, there were 15 stations.

Data obtained from the external survey indicated that 72,114 vehicles entered or exited the study area during an average 24 hour period. Of these, 40,250 were through trips. The remaining 31,864 external trips were distributed internal zones through the use of a gravity model distribution program using as input: (1) actual trip productions at external stations, (2) attraction factors produced by the multiple regression equation, (3) a trip length frequency

The initial regression equation for estimating trip attraction factors was:

$$Y = a + bX_1 + cX_2 + dX_3 + eX_4 + fX_5 + gX_6$$

Where Y = zonal attraction factor

X_1 = zonal industrial employment

X_2 = zonal retail and wholesale employment

X_3 = zonal highway terminal employment

X_4 = zonal public transportation terminal employment

X_5 = zonal service employment

X_6 = zonal dwelling units

a, b, c, d, e, f, g = constant determined by regression analysis

Preliminary analysis indicated that the independent variable X_5 did not significantly increase the predictions quality of the equation and was therefore dropped in the final analysis.

Theoretical regression equation used to calculate attraction factors for OHS and MES trips was:

$$Y = 052.06 + 1.38X_1 + 00.66X_2 + 019.26X_3 + 9.20X_4 + .91X_6$$

The attraction factors computed by this equation are included in Table A-5. In testing the significance of the equation, the coefficient of determination (R^2) was calculated to be .99. This is the proportion of the total variation explained by the regression equation. Multiple regression statistical data are given below in Table A-6.

Trip Distribution: The gravity model trip distribution program was used to distribute internal trips. Input to this program included: (1) a trip length frequency curve, (2) zonal attraction factors, (3) zonal trip productions, and (4) travel time between zone centroids. Table A-7, below gives the trip length frequency curves used in the Ypsilanti study.

ZONE	DWELLING UN W	N-W	T	TRUCK TRIPS	COMMR AUTO TRIPS	TAXI TRIPS	TOTAL TRIPS	INTRL TRIPS	HOME WORK TRIPS	OTHER HOME TRIPS	NON HOME INTRL	NON HOME EXTRL	ADJST WORK ATTRS	ADJST OTHER ATTRS	ADJST NON-H ATTRS
1	19			40	34		199	121	28	65	28		83	414	377
2	92			20	20		533	325	75	176	75		6	38	35
3	55	4		27			361	220	51	119	51		68	216	197
4	69						414	253	58	137	58		1	13	12
5	29	7					216	132	30	71	30			24	22
6	4	125	1				597	364	84	197	84		7	91	83
7	106	2	1				650	397	91	214	91		66	165	162
8	40			67			307	187	43	101	43		21	53	48
9	17	27		27			210	128	29	69	29		6	26	24
10	4	7		67			116	71	16	38	16		118	164	149
11	33	5		40			257	157	36	85	36		46	98	90
12	19	35					282	172	40	93	40		2	10	9
13	1	5					19	12	3	6	3			11	10
14		17					60	37	9	20	9		14	7	6
15	1	10		248			314	192	44	104	44		21	88	80
16		23					85	52	12	28	12			4	3
17	2	2		47			71	43	10	23	10		518	550	500
18	2	12		27			86	52	12	28	12		6	50	46
19	11			13			71	43	10	23	10		7	54	49
20	4			34			55	34	8	18	8		5	14	12
21	14						95	58	13	31	13			26	23
22	183		1	20			1574	960	221	518	221		27	161	147
23	31	1		47			208	127	29	69	29		40	131	119
24														2	2
25	31	12					288	176	40	95	40		20	14	13
26													18	71	64
27	28			7			172	105	24	57	24		11	36	33
28	35						210	128	29	69	29		10	28	26
29	6						36	22	5	12	5			6	5
30	11	2		27			99	60	14	32	14		4	13	12
31	3			13			28	17	4	9	4		10	55	50
32	7	1					39	24	6	13	6		2	10	9
33	55	7					349	213	49	115	49			26	25
34	7	3					57	35	8	19	8				
35	6	4					46	28	6	15	6				
TOTAL	925	311	12	771	54		8104	4945	1137	2669	1137	1304	1137	2669	2442

DU OCCUPANCY R

	W	HIGH
WHITE	2	2.9
NON-WHITE	2	3.2

TRIP PERCENTAGE

INTERNAL OF TOTAL	61
HOME BASED WORK OF INTERNAL	23
OTHER HOME BASED OF INTERNAL	54
NON HOME BASED OF INTERNAL	23

The initial regression equation for estimating trip attraction factors was:

$$Y = a + bX_1 + cX_2 + dX_3 + eX_4 + fX_5 + gX_6$$

Where Y = zonal attraction factor
X_1 = zonal industrial employment
X_2 = zonal retail and wholesale employment
X_3 = zonal highway retail employment
X_4 = zonal service employment
X_5 = zonal dwelling units
X_6 = zonal dwelling units
a, b, c, d, e, f, g = constant determined by regression analysis

Preliminary analysis indicated that the independent variable X_2 did not significantly increase the predictive quality of the equation and was therefore dropped in the final analysis.

The final regression equation used to calculate attraction factors for OHB and MHB trips was:

$$Y = 952.04 + 2.36X_1 + 60.66X_3 + 19.26X_4 + 9.30X_5 + 9.9X_6$$

The attraction factors computed by this equation are included in Table A-5. In testing the significance of the equation, the coefficient of determination (R^2) was calculated to be .99. This is the proportion of the total variation explained by the regression equation. Multiple regression statistical data are given below in Table A-6.

Trip Distribution: The gravity modal trip distribution program was used to distribute internal trips. Input to this program included: (1) a trip length frequency curve, (2) zonal attraction factors, (3) zonal trip productions, and (4) travel time between zone centroids. Table A-7, below gives the trip length frequency curves used in the Apex study.

TABLE A-5

1978 DWELLING UNIT, POPULATION AND TRIP DATA

ZONE	DWELLING UNITS W	DWELLING UNITS N-W	DWELLING UNITS TOT	WHITE POPULATION HGH	WHITE POPULATION MED	WHITE POPULATION LOW	WHITE POPULATION TOT	NON-WHITE POPULATION HGH	NON-WHITE POPULATION MED	NON-WHITE POPULATION LOW	NON-WHITE POPULATION TOT	TOTAL POPULATION	DWELLING UNITS WHITE HGH	DWELLING UNITS WHITE MED	DWELLING UNITS WHITE LOW	DWELLING UNITS NON-WHITE HGH	DWELLING UNITS NON-WHITE MED	DWELLING UNITS NON-WHITE LOW	SPECIAL VEHICLES TRUCKS	SPECIAL VEHICLES COMMR AUTOS	SPECIAL VEHICLES TAXIS	UNADJ WORK ATTRS	UNADJ OTHER ATTRS	TRIPS BY DWELLING UNITS WHITE HGH	TRIPS BY DWELLING UNITS WHITE MED	TRIPS BY DWELLING UNITS WHITE LOW	TRIPS BY DWELLING UNITS NON-WHITE HGH	TRIPS BY DWELLING UNITS NON-WHITE MED	TRIPS BY DWELLING UNITS NON-WHITE LOW	AUTO TRIPS	TRUCK TRIPS	COMMR AUTO TRIPS	TAXI TRIPS	TOTAL TRIPS	INTRL TRIPS	HOME WORK TRIPS	OTHER HOME TRIPS	NON HOME INTRL	NON HOME EXTRL	ADJST WORK ATTRS	ADJST OTHER ATTRS	ADJST NON-H ATTRS
1	19		19	12	45		57					57	4	15					6	5		218	2479	35	90					125	40	34		199	121	28	65	28		83	414	377
2	92		92		213	67	280					280		71	21				3	3		15	227		426	67				493	20	20		533	325	75	176	75		6	38	35
3	55	4	59		150	16	166		7	8	15	181		50	5		2	2	4			178	1296		300	16		12	6	334	27			361	220	51	119	51		68	216	197
4	69		69		207		207					207		69								2	76		414					414				414	253	58	137	58		1	13	12
5	29	7	36	12	72	3	87		14	12	26	113	4	24	1		4	3					142	35	144	3		24	10	216				216	132	30	71	30			24	22
6	4	125	129		9	3	12		221	248	469	481		3	1		63	62				19	543		18	3		378	198	597				597	366	86	197	84		7	91	83
7	106	2	108	38	249	32	319			8	8	327	13	83	10			2				174	989	114	498	32			6	650				650	397	91	214	91		66	165	162
8	40		40		120		120					120		40					10			56	317		240					240	67			307	187	43	101	43		21	53	48
9	17	27	44	3	27	22	52		14	92	106	158	1	9	7		4	23	4			15	156	9	54	22		24	74	183	27			210	128	29	69	29		6	26	24
10	4	7	11		9	3	12		7	20	27	39		3	1		2	5	10			309	980		18	3		12	16	49	67			116	71	16	38	16		118	164	149
11	33	5	38	3	96		99			20	20	119	1	32				5	6			120	589	9	192				16	217	40			257	157	36	85	36		46	98	90
12	19	35	54		51	6	57	3	70	56	129	186		17	2	1	20	14				5	57		102	6	9	120	45	282				282	172	40	93	40		2	10	9
13	1	5	6			3	3			20	20	23			1			5					68			3			16	19				19	12	3	6	3			11	10
14		17	17						7	60	67	67					2	15				38	40					12	48	60				60	37	9	20	9		14	7	6
15	1	10	11	3			3		32	4	36	39	1				9	1	37			56	527	9				54	3	66	248			314	192	44	104	44		21	88	80
16		23	23						14	76	90	90					4	19				1	23					24	61	85				85	57	12	28	12			4	3
17	2	2	4		6		6		7		7	13		2			2		7			1360	3291		12			12		24	47			71	43	10	23	10		518	550	500
18	2	12	14		6		6		11	36	47	53		2			3	9	4			17	302	9	12			18	29	59	27			86	52	12	28	12		6	50	46
19	11		11	3	18	13	34					34	1	6	4				2			18	321	9	36	13				58	13			71	43	10	23	10		7	54	49
20	4		4	3	3	6	12					12	1	1	2				5			14	81	35	6	6				21	34			55	34	8	18	8		5	14	12
21	14		14	12	30		42					42	4	10									153	1434	60					95				95	58	13	31	13			26	23
22	183		183	473	60		533					533	163	20					3			70	965	18	120					1554	20			1574	960	221	518	221		27	161	147
23	31	1	32	6	51	38	95			4	4	99	2	17	12			1	7			106	784		102	38			3	161	47			208	127	29	69	29		40	131	119
24																							11	211										2								2
25	31	12	43	70	18	3	91			48	48	139	24	6	1			12				53	83		36	3			38	288				288	176	40	95	40		20	14	13
26																						47	424	26																18	71	64
27	28		28	9	63	13	85					85	3	21	4				1			30	214	26	126	13				165	7			172	105	24	57	24		11	36	33
28	35			9	87	10	106					106	3	29	3							25	168		174	10				210				210	128	29	69	29		10	28	26
29	6				18		18					18		6									33	9	36					36				36	22	5	12	5			6	5
30	11	2	13	3	27	3	33			8	8	41	1	9	1			2	4			9	77		54	3			6	72	27			99	60	14	32	14		4	13	12
31	3		3		6	3	9					9		2	1				2			26	331		12	3				15	13			28	17	4	9	4		10	55	50
32	7	1	8		15	6	21			4	4	25		5	2			1				2	59		30	6			3	39				39	24	6	13	6		2	10	9
33	55	7	62		159	6	165		4	24	28	193		53	2		1	6					163		318	6		6	19	349				349	213	49	115	49			26	25
34	7	3	10		21		21		7	4	11	32		7			2	1						9	42			12	3	57				57	35	8	19	8				
35	6	4	10	3	9	6	18			16	16	34	1	3	2			4					2		18	6			13	46				46	28	6	15	6				
TOTAL	925	311	1236	662	1845	262	2769	3	415	768	1186	3955	227	615	83	1	118	192	115	8		2983	15971		5949			1330		7279	771	54		8104	4945	1137	2669	1137	1304	1137	2669	2442

OU OCCUPANCY RATES (1978)

	HIGH	MEDIUM	LOW
WHITE	2.9	3.0	3.2
NON-WHITE	3.2	3.5	4.0

AUTO TRIPS / D.U.

	HIGH	MEDIUM	LOW
WHITE	8.8	6.0	3.2
NON-WHITE	8.8	6.0	3.2

TRUCK TRIPS / TRUCK 46.7
COMMERCIAL AUTO TRIPS / COMMERCIAL AUTO 6.7
TAXI TRIPS / TAXI 40.0

TRIP PERCENTAGE

INTERNAL OF TOTAL	61
HOME BASED WORK OF INTERNAL	23
OTHER HOME BASED OF INTERNAL	54
NON HOME BASED OF INTERNAL	23

TABLE A-5

1970 DWELLING UNIT, POPULATION AND TRIP DATA

TABLE A-6

Multiple Regression Statistical Data				
Variable	Coefficient	Standard Error of Coefficient	Value	Beta Coefficient
X_1	2.38175	.10014	23.78394	.7990
X_2	10.65642	2.17210	4.90605	.2165
X_4	19.25652	4.01458	4.79664	.2077
X_5	9.30227	1.38664	6.60847	.3309
X_6	.90595	.67579	1.34058	.0526

Constant = 52.03526
Multiple Correlation Coefficient (R^2) = .9850
Standard Error of the Estimate = 133.9635
Standard Error of the Estimate/Mean = .2789
Mean Y Value =

curve as determined by survey, and (4) station to zone travel times. The trip length frequency curve used for the external gravity model is given in Table A-7. The distribution of external traffic was accomplished simulataneously with distribution of internal traffic. External stations were treated the same as internal zones with the exception that they only produced trips and did not attract them.

TABLE A-7

Trip Length Frequency Curves				
Travel Time (Minutes)	Percent HBW Trips	Percent OHB Trips	Percent NHB Trips	Percent External Trips
1	0.0	1.84	7.62	0.84
2	0.35	7.08	2.62	19.01
3	13.28	20.76	22.44	18.84
4	30.34	34.39	24.82	23.58
5	30.43	30.54	27.52	12.69
6	12.84	7.87	8.40	12.66
7	9.41	4.87	2.33	3.28
8	2.46	2.06	3.60	4.45
9	0.88	.49	0.53	4.30
10	0.0	.11	0.12	0.0

Accuracy Checks

The synthetic method of developing internal travel patterns was checked through the assignment of internal, external, and through trips to the existing major street network and by comparison to established screenlines and actual ground counts. Travel was assigned to the major street system by a traffic assignment program on a minimum travel time basis.

The screenlines established for control purposes are shown on the planning area zone map (Figure 4). The traffic volumes determined by traffic recording devices or manual counts were compared to the assigned volumes as set forth by computer assignments. The results of the screenline comparisons are given in Table A-8 below, and were considered satisfactory.

TABLE A-8

Screenline Accuracy Checks			
Screenline	Actual Crossing	Assigned Crossing	Percent Accuracy
A	28,371	26,813	106%
B	18,746	18,698	100%

Future Year Travel

2000 Internal Trips - The internal travel patterns for the year 1995 were estimated using 2000 planning area data and following the same procedures that were used to estimate 1978 travel.

Dwelling unit trip generation rates for 2000 were assumed to remain constant.

The estimated trip generation rate for commercial trucks and autos was also assumed to remain constant at 6.7.

Trip productions and attractions were distributed to the zones based on land use growth shown in the Land Use Plan, Apex, N. C.

The percent breakdown of internal trips by purpose and the percentage of non-home based trips generated by external traffic were assumed to remain constant. Non-home based trips produced by internal traffic were separated from the home zone and added to the non-home based trips produced by external traffic. The total non-home based trips were then redistributed to the traffic zones on the basis of the non-home based trip attraction factors for the various zones for the year 2000.

Trip attraction factors for other home based trips and non-home based trips were determined by the input of 2000 zonal employment into the regression equation reestablished on the basis of the 1978 zonal employment data. Trip attraction factors for home based work trips were total 2000 zonal employment. The estimated distribution of 2000 zonal employment is given in Table A-9. The total employment within the planning area was expected to be directly proportional to planning area population growth.

The method of distributing 2000 internal trips was identical to that used to distribute 1978 internal trips with the exception that 2000 zone-to-zone travel times were used (shown in Table A-10). The 2000 zone-to-zone travel times were obtained from a "build vine" computer program applied to the alternate networks. The 2000 trip summary derived from this distribution is available with the future year trip tables. The year 2000 dwelling unit, population, and trip data is given in Table A-11.

2000 External and Through Trips - External and through traffic volumes at stations were projected on the basis of historical trends. Table A-12 gives historical counts and future projections for all external stations.

The ratio of external traffic to through traffic was assumed to remain constant through the planning period. The

TABLE A-9

2000 EMPLOYMENT DATA BY ZONE AND TYPE

ZONE	INDUSTRIAL	RETAIL & WHOLESALE	HIGHWAY RETAIL	OFFICE	SERVICE	TOTAL
1	17	60	12	38	91	2479
2	0	0	0	0	15	227
3	0	45	47	4	82	1296
4	0	2	0	0	0	76
5	0	0	0	0	0	142
6	0	0	0	0	19	543
7	107	5	11	20	31	989
8	40	5	0	10	1	317
9	0	5	0	4	6	156
10	293	16	0	0	0	980
11	21	0	45	5	49	589
12	0	0	0	0	5	57
13	0	0	0	0	0	68
14	0	0	0	0	38	40
15	51	2	0	0	3	527
16	0	0	0	0	0	23
17	1358	0	0	0	2	3291
18	0	0	0	13	4	302
19	0	18	0	0	0	321
20	14	0	0	0	0	81
21	0	0	0	0	0	153
22	0	0	0	0	70	965
23	62	26	0	2	1	784
24	0	0	0	0	0	11
25	0	0	0	0	53	83
26	0	0	0	0	47	424
27	0	30	0	0	0	214
28	0	24	0	0	1	168
29	0	0	0	0	0	33
30	9	0	0	0	0	77
31	0	0	26	0	0	331
32	1	0	0	0	1	59
33	0	0	0	0	0	163
34	0	0	0	0	0	0
35	0	0	0	0	0	2

TABLE A-10

TRIP LENGTH FREQUENCY CURVES

PERCENT TRIPS DISTRIBUTED

2000

Trip Length (minutes)	Home Based Work Trips	Other Home Based Trips	Non Home Based Trips	External Trips
1	0.	0.98	4.74	0.68
2	0.23	3.38	3.42	21.44
3	9.59	15.95	20.86	16.27
4	26.49	25.31	30.19	21.49
5	22.61	26.09	23.32	14.82
6	19.39	16.25	11.08	11.51
7	12.50	8.00	3.23	4.38
8	4.48	2.50	2.29	3.85
9	4.64	1.36	0.83	5.33
10	0.07	0.20	0.06	0.25

ZONE	DWELLING U W	N-W	TRUCK TRIPS	COMMR AUTO TRIPS	TAXI TRIPS	TOTAL TRIPS	INTRL TRIPS	HOME WORK TRIPS	OTHER HOME TRIPS	NON HOME INTRL	NON HOME EXTRL	ADJST WORK ATTRS	ADJST OTHER ATTRS	ADJST NON-H ATTRS
1			80	67		147	90	21	49	21		142	543	463
2	42		40	40		273	167	38	90	38		22	98	83
3	30	10	54	34		244	149	34	80	34		109	543	463
4	80	20				516	315	72	170	72		22	406	345
5	30	16				267	163	37	88	37			16	14
6	75	150				1140	695	160	375	160		13	88	75
7	150	25		34		1154	704	162	380	162		87	268	241
8	50		134			434	265	61	143	61		44	131	111
9	125	100	54			1376	839	193	453	193		94	224	191
10	35	35	134	101		613	374	86	202	86		207	267	227
11	40	10	80			388	237	55	128	55		89	338	288
12	53	42				528	322	74	174	74		33	74	63
13		35				182	111	26	60	26		11	54	46
14		42				210	128	29	69	29		22	69	58
15	5	27	496			682	416	96	225	96		28	37	31
16		40		67		243	148	34	80	34		142	210	179
17			94	168		262	160	37	86	37		872	789	672
18	5	24	54			194	118	27	64	27		174	238	203
19	452		27			3445	2101	483	1135	483		76	295	251
20	75	25	67			667	407	94	220	94		56	114	97
21	70	20				540	329	76	178	76		22	39	33
22	170	55	40			1796	1096	252	592	252			40	34
23	55		94	67		435	265	61	143	61		63	151	128
24												12	64	54
25	50	20				420	256	59	138	59		23	176	150
26	28					168	102	23	55	23		21	83	70
27	39		13			272	166	38	90	38		26	119	102
28	50			34		351	214	49	116	49		59	129	110
29	10	10				120	73	17	39	17		57	236	201
30	25		54			190	116	27	63	27		55	95	81
31	22		27			139	85	20	46	20		24	100	85
32	35	24				301	184	42	99	42		2	24	20
33	75	35				660	403	93	218	93			24	20
34	10	10				114	70	16	38	16			11	9
35	11	9				120	73	17	39	17			11	9
TOTAL	1897	784 2	1542	612		18591	11341	2609	6125	2609	2608	2607	6104	5207

OCCUPANCY RATES

	OW
WHITE	.2
NON-WH	.2

TRIP PERCENTAGE

INTERNAL OF TOTAL	61
HOME BASED WORK OF INTERNAL	23
OTHER HOME BASED OF INTERNAL	54
NON HOME BASED OF INTERNAL	23

TABLE A-11

2000 DWELLING UNIT, POPULATION AND TRIP DATA

ZONE	DWELLING UNITS W	N-W	TOT	WHITE-------POPULATION-------NON-WHITE HGH	MED	LOW	TOT	HGH	MED	LOW	TOT	TOTAL POPULATION	-----DWELLING UNITS----- WHITE HGH	MED	LOW	NON-WHITE HGH	MED	LOW	--SPECIAL VEHICLES-- TRUCKS	COMMR AUTOS	TAXIS	UNAOJ WORK ATTRS	UNAOJ OTHER ATTRS	TRIPS BY DWELLING UNITS ---WHITE--- HGH	MED	LOW	--NON-WHITE-- HGH	MED	LOW	AUTO TRIPS	TRUCK TRIPS	COMMR AUTO TRIPS	TAXI TRIPS	TOTAL TRIPS	INTRL TRIPS	HOME WORK TRIPS	OTHER HOME TRIPS	NON HOME INTRL	NON HOME EXTRL	ADJST WORK ATTRS	ADJST OTHER ATTRS	ADJST NON-H ATTRS
1																			12	10		325	3505									80	67		147	90	21	49	21			142	543	463
2	42		42		63	67	130					130		21	21				6	6		50	631		126	67					193	40	40		273	147	38	90	38			22	98	83
3	30	10	40		30	64	94			40	40	134		10	20			10	8	5		250	3505		60	64			32	156	54	34		244	149	34	80	34			109	543	463
4	80	20	100		150	96	246		70		70	316		50	30		20					50	2617		300	96		120		516				516	315	72	170	72			22	406	345
5	30	16	46	12	72	6	90		39	20	59	149	4	24	2		11	5					103	35	146	6		66	16	267				267	163	37	88	37				16	14
6	75	150	225		150	80	230		350	200	550	780		50	25		100	50				29	566		300	80		600	160	1140				1140	695	160	375	160			13	88	75
7	150	25	175	145	225	80	450		88		88	538	50	75	25		25			5		200	1728	440	450	80		150		1120		34		1154	704	162	380	162			87	268	241
8	50		50		150		150					150		50					20			100	844		300					300	134			434	265	61	143	61			44	131	111
9	125	100	225	73	270	32	375		263	100	363	738	25	90	10		75	25	8			215	1445	220	540	32		450	80	1322	54			1376	839	193	453	193			94	224	191
10	35	35	70		75	32	107		105	20	125	232		25	10		30	5	20	15		475	1722		150	32		180	16	378	134	101		613	374	86	202	86			207	267	227
11	40	10	50	15	105		120		28	8	36	156	5	35	2		8	2	12			204	2182	44	210			48	6	308	80			388	237	55	128	55			89	338	288
12	53	42	95		150	10	160		105	92	153	313		50	3		30	12				75	476		300	10		180	38	528				528	322	76	174	76			33	74	63
13		35	35						88		128	128					25	10				25	351					150	32	182				182	111	26	60	26			11	54	46
14		42	42						95	48	155	155					27	15				50	443					162	48	210				210	128	29	69	29			22	69	58
15	5	27	32		15		15		88		96	111		5			25	2	74			65	236		30			150	6	186	496			682	416	96	225	96			28	37	31
16		40	40						60		152	152					17	23		10		325	1358					102	74	176		67		243	148	34	80	34			142	210	179
17																			14	25		2000	5092								94	168		262	160	37	86	37			872	789	672
18	5	24	29		15		15		42		90	105		5			12	12	8			400	1538		30			72	38	140	54			194	118	27	64	27			174	238	203
19	452		452	731	600		1331					1331	252	200					4			175	1905	2218	1200					3418	27			3445	2101	483	1135	483			76	295	251
20	75	25	100		225		225		88		88	313		75			25		10			128	734		450			150		600	67			667	407	94	220	94			56	114	97
21	70	20	90		210		210		70		70	280		70			20					50	253		420			120		540				540	329	76	178	76			22	39	33
22	170	55	225	348	150		498	80	105		185	683	120	50		25	30		6				257	1056	300		220	180		1756	40			1796	1096	252	592	252				40	34
23	55		55		105	64	169					169		35	20				14	10		145	973		210	64				274	94	67		435	265	61	143	61			63	151	128
24																						28	411																			12	64	54
25	50	20	70	29	120		149		35	40	75	224	10	40			10	10				53	1137	88	240			60	32	420				420	256	59	138	59			23	176	150
26	28		28		84		84					84		28								49	533		168					168				168	102	23	55	23			21	83	70
27	39		39	26	90		116					116	9	30					2			60	769	79	180					259	13			272	166	38	90	38			26	119	102
28	50		50	29	108	13	150					150	10	36	4					5		135	833	88	216	13				317		34		351	214	49	116	49			59	129	110
29	10	10	20		30		30		35		35	65		10			10					130	1524		60			60		120				120	73	17	39	17			57	236	201
30	25		25		60	16	76					76		20	5				8			125	616		120	16				136	54			190	116	27	63	27			55	95	81
31	22		22		45	22	67					67		15	7				4			55	644		90	22				112	27			139	85	20	46	20			24	100	85
32	35	24	59		75	32	107		53	36	89	196		25	10		15	9				5	153		150	32		90	29	301				301	184	42	99	42			2	24	20
33	75	35	110	29	195		224		88	40	128	352	10	65			25	10					152	88	390			150	32	660				660	403	93	218	93				24	20
34	10	10	20		30		30		28	8	36	66		10			8	2					70		60			48	6	114				114	70	16	38	16				11	9
35	11	9	20		33		33		32		32	65		11			9						70		66			54		120				120	73	17	39	17				11	9
TOTAL	1397	784	2681	1437	3630	614	5681	80	1955	808	2843	8524	495		192		557		230						12230			4207		16437	1542	612		18591	11341	2609	6125	2609	2608	2607	6104	5207

OCCUPANCY RATES	HIGH	MEDIUM	LOW
WHITE	2.9	3.0	3.2
NON-WHITE	3.2	3.5	4.0

TRIPS / DU	HIGH	MEDIUM	LOW
WHITE	8.8	6.0	3.2
NON-WHITE	8.8	6.0	3.2

TRUCK TRIPS / TRUCK	6.7
COMMERCIAL AUTO TRIPS / COMMERCIAL AUTO	6.7
TAXI TRIPS / TAXI	40.0

TRIP PERCENTAGE	
INTERNAL OF TOTAL	61
HOME BASED WORK OF INTERNAL	23
OTHER HOME BASED OF INTERNAL	54
NON HOME BASED OF INTERNAL	23

TABLE A-11

2000 DWELLING UNITS, POPULATION AND TRIP DATA

HISTORICAL, PROJECTED 2000 AND 2005

AVERAGE DAILY TRAFFIC

TABLE A-12

	STATION	1965	1970	1978	2000	2005
1	SR 1613	200	650	861	1600	1768
2	SR 1011	1600	1700	2680	4500	4914
3	US 64E	1550	3050	7090	23000	26616
4	US 1N	--	--	11290	22700	25293
5	SR 1010	1350	1600	2560	6000	6782
6	NC 55S	3340	5200	8520	15000	16473
7	SR 1153	250	450	10	200	243
8	US 1S	--	--	6150	12000	13330
9	SR 1011	1400	1600	2621	4000	4313
10	SR 1162	--	--	2	100	122
11	SR 1160	--	--	460	800	877
12	US 64W	2140	2800	6010	12000	13361
13	NC 55N	3080	3900	5820	11000	12177
14	SR 1611	650	430	860	1200	1277
15	Lake Pine Dr.	--	--	1531	2000	2107

2000 through-trip patterns were estimated by applying growth factors resulting from the projection of through trip ends at external stations to the 2000 through-trip movements. The estimated 2000 through-trip ends were balanced using the Fratar trip-end balancing computer program.

The gravity model was used to distribute external traffic to internal zones. Input to the model included: (1) external trips generated at external stations; (2) attraction factors from regression equations; (3) 1978 trip length distribution curves, and (4) 2000 station-to-zone travel times.

Future Year Travel

2005 Internal Trips - The internal travel patterns for the year 2005 were estimated using 2005 planning area data and following the same procedures that were used to estimate 1978 travel.

Dwelling unit trip generation rates for 2005 were assumed to remain constant.

The estimated trip generation rate for commercial trucks and autos was also assumed to remain constant at 6.7.

Trip productions and attractions were distributed to the zones based on a logical extension of land use growth shown in the Apex Land Use Plan.

The percent breakdown of internal trips by purpose and the percentage of non-home based trips generated by external traffic were assumed to remain constant. Non-home based trips produced by internal traffic were separated from the home zone and added to the non-home based trips produced by external traffic. The total non-home based trips were then redistributed to the traffic zones on the basis of the non-home based trip attraction factors for the various zones for the year 2005.

Trip attraction factors for other home based trips and non-home based trips were determined by the input of 2005 zonal employment into the regression equation reestablished on the basis of the 1980 zonal employment data. Trip attraction factors for home based work trips were total 2005 zonal employment. The estimated distribution of 2005 zonal employment is given in Table A-13. The total employment within the planning area was expected to be directly proportional to planning area population growth.

The method of distributing 2005 internal trips was identical to that used to distribute 1978 internal trips with the exception that 2000 zone-to-zone travel times were used. The 2000 zone-to-zone travel times were obtained from a "build vine" computer program applied to the alternate networks. The 2005 trip summary derived from this distribution is available with the future year trip tables.

2005 External and Through Trips - External and through traffic volumes at stations were projected on the basis of historical trends. Table A-14 gives historical counts and future projections for all external stations.

The ratio of external traffic to through traffic was assumed to remain constant through the planning period. The 2005 through-trip patterns were estimated by applying growth factors resulting from the projection of through trip ends at external stations to the 2005 through-trip movements. The estimated 2005 through-trip ends were balanced using the Fratar trip-end balancing computer program.

The gravity model was used to distribute external traffic to internal zones. Input to the model included: (1) external trips generated at external stations; (2) attraction factors from regression equations; (3) 1980 trip length distribution curves, and (4) 2005 station-to-zone travel times.

TABLE A-13

2005 Employment Data By Zone and Type						
Zone	Industrial	Retail & Wholesale	Highway Retail	Office	Service	Total
1	18	63	13	40	96	230
2	0	0	0	0	16	16
3	0	47	49	4	86	186
4	0	2	0	0	0	2
5	0	0	0	0	0	0
6	0	0	0	0	20	20
7	112	5	12	21	33	183
8	42	5	0	11	1	59
9	0	5	0	4	6	15
10	308	17	0	0	0	325
11	22	0	47	5	51	125
12	0	0	0	0	5	5
13	0	0	0	0	0	0
14	0	0	0	0	40	40
15	54	0	0	0	3	57
16	0	0	0	0	0	0
17	1426	0	0	0	2	1428
18	0	0	0	14	4	18
19	0	19	0	0	0	19
20	15	0	0	0	0	15
21	0	0	0	0	0	0
22	0	0	0	0	74	74
23	65	27	0	2	1	95
24	0	0	0	0	0	0
25	0	0	0	0	56	56
26	0	0	0	0	49	49
27	0	32	0	0	0	32
28	0	25	0	0	1	26
29	0	0	0	0	0	0
30	0	0	0	0	0	9
31	0	0	27	0	0	27
32	1	0	0	0	1	2
33	0	0	0	0	0	0
34	0	0	0	0	0	0
35	0	0	0	0	0	0

BASIC INTERNAL DATA /
APEX
12/15/81 P56504

ZONE	DWELLING UNITS W	N-W	TOT	TRUCK TRIPS	COMMR AUTO TRIPS	TAXI TRIPS	TOTAL TRIPS
1							
2	44		44	87	74		161
3	32	11	43	40	40		282
4	85	21	106	54	34		256
5	31	17	48				546
6	79	158	237				279
7	158	26	184				1201
8	53		53		34		1213
9	132	105	237	141			459
10	37	37	74	54			1445
11	42	11	53	141	107		647
12	56	45	101	87			413
13		37	37				562
14		44	44				191
15	5	28	33				219
16		42	42	523			715
17					74		259
18	5	26	31	101	174		275
19	475		475	54			204
20	79	26	105	27			3619
21	74	21	95	74			704
22	179	58	237				570
23	58		58	40			1888
24				101	74		464
25	53	22	75				
26	29		29				450
27	42		42				174
28	53		53	13			293
29	11	11	22		34		372
30	26		26				132
31	24		24	60			202
32	37	26	63	27			149
33	79	37	116				319
34	11	11	22				696
35	12	10	22				126
							132
TOTAL	2001	830	2831	1624	645		19617

```
**********************
*  OCCUPANCY RATES   *
*            WHITE   *
*            NON-WHITE
**********************
```

```
******
LOW  *
3.2  *
3.2  *
7    *
7    *
0    *
******
```

BASIC INTERNAL DATA / TRIPS BY PURPOSE
APEX 2005 DATA
12/15/81 P56504

ZONE	INTRL TRIPS	HOME WORK TRIPS	OTHER HOME TRIPS	NON HOME INTRL	NON HOME EXTRL	ADJST WORK ATTRS	ADJST OTHER ATTRS	ADJST NON-H ATTRS
1	98	23	53	23		150	626	534
2	172	40	93	40		23	113	56
3	156	36	84	36		115	467	398
4	333	77	180	77		23	26	22
5	170	39	92	39			18	16
6	733	169	396	169		13	101	86
7	740	170	400	170		92	308	263
8	280	64	151	64		46	151	128
9	881	203	476	203		99	258	220
10	395	91	213	91		219	307	262
11	252	58	136	58		94	389	332
12	343	79	185	79		35	85	73
13	117	27	63	27		11	63	54
14	134	31	72	31		23	79	67
15	436	100	235	100		30	42	36
16	158	36	85	36		150	242	207
17	168	39	91	39		922	909	775
18	124	29	67	29		184	275	234
19	2208	508	1192	508		81	340	290
20	429	99	232	99		59	131	112
21	348	80	188	80		23	45	39
22	1152	265	622	265			46	39
23	283	65	153	65		67	174	148
24						13	73	63
25	275	63	149	63		25	203	173
26	106	24	57	24		22	95	81
27	179	41	97	41		28	137	117
28	227	52	123	52		62	149	127
29	81	19	44	19		60	272	232
30	123	28	66	28		58	110	94
31	91	21	49	21		25	115	98
32	195	45	105	45		2	27	23
33	425	98	230	98			27	23
34	77	18	42	18			13	11
35	81	19	44	19			13	11
TOTAL	11970	2756	6465	2756	2738	2754	6429	5484

```
*****************************************
*  TRIP PERCENTAGE                      *
*    INTERNAL OF TOTAL              61  *
*    HOME BASED WORK OF INTERNAL    23  *
*    OTHER HOME BASED OF INTERNAL   54  *
*    NON HOME BASED OF INTERNAL     23  *
*****************************************
```

TABLE A-13

2005 Employment Data By Zone and Type						
Zone	Industrial	Retail & Wholesale	Highway Retail	Office	Service	Total
1	18	63	13	40	96	230
2	0	0	0	0	16	16
3	0	47	49	4	86	186
4	0	2	0	0	0	2
5	0	0	0	0	0	0
6	0	0	0	0	20	20
7	112	5	12	21	33	183
8	42	5	0	11	1	59
9	0	5	0	4	6	15
10	308	17	0	0	0	325
11	22	0	47	5	51	125
12	0	0	0	0	5	5
13	0	0	0	0	0	0
14	0	0	0	0	40	40
15	54	0	0	0	3	57
16	0	0	0	0	0	0
17	1426	0	0	0	2	1428
18	0	0	0	14	4	18
19	0	19	0	0	0	19
20	15	0	0	0	0	15
21	0	0	0	0	0	0
22	0	0	0	0	74	74
23	65	27	0	2	1	95
24	0	0	0	0	0	0
25	0	0	0	0	56	56
26	0	0	0	0	49	49
27	0	32	0	0	0	32
28	0	25	0	0	1	26
29	0	0	0	0	0	0
30	0	0	0	0	0	9
31	0	0	27	0	0	27
32	1	0	0	0	1	2
33	0	0	0	0	0	0
34	0	0	0	0	0	0
35	0	0	0	0	0	0

APPENDIX A, TABLE 14

2005 DWELLING UNIT, POPULATION AND TRIP DATA

BASIC INTERNAL DATA / POPULATION
APEX 2005 DATA
12/15/81 P56504

ZONE	DWELLING UNITS W	N-W	TOT	WHITE-POPULATION HGH	MEO	LOW	TOT	NON-WHITE HGH	MEO	LOW	TOT	TOTAL POPULATION
1												
2	44		44		66	70	136					136
3	32	11	43		33	67	100			44	44	144
4	85	21	106		159	102	261		74		74	335
5	31	17	48	12	75	6	93		42	20	62	155
6	79	158	237		159	83	242		368	212	580	822
7	158	26	184	154	237	83	474		91		91	565
8	53		53		159		159					159
9	132	105	237	75	285	35	395		277	104	381	776
10	37	37	74		78	35	113		112	20	132	245
11	42	11	53	15	111		126		32	8	40	166
12	56	45	101		159	10	169		112	52	164	333
13		37	37						91	44	135	135
14		44	44						98	64	162	162
15	5	28	33		15		15		91	8	99	114
16		42	42						63	96	159	159
17												
18	5	26	31		15		15		46	52	98	113
19	475		475	769	630		1399					1399
20	79	26	105		237		237		91		91	328
21	74	21	95		222		222		74		74	296
22	179	58	237	365	159		524	83	112		195	719
23	58		58		111	67	178					178
24												
25	53	22	75	32	126		158		39	44	83	241
26	29		29		87		87					87
27	42		42	29	96		125					125
28	53		53	32	114	13	159					159
29	11	11	22		33		33		39		39	72
30	26		26		63	16	79					79
31	24		24		48	26	74					74
32	37	26	63		78	35	113		56	40	96	209
33	79	37	116	32	204		236		91	44	135	371
34	11	11	22		33		33		32	8	40	73
35	12	10	22		36		36		35		35	71
TOTAL	830		1515		648		83		860			9000
	2001		2831		3828		5991		2066		3009	

OCCUPANCY RATES	HIGH	MEDIUM	LOW
WHITE	2.9	3.0	3.2
NON-WHITE	3.2	3.5	4.0

INTERNAL DATA LISTING INPUT DATA
APEX
12/15/81 P56504

ZONE	DWELLING UNITS WHITE HGH	MEO	LOW	NON-WHITE HGH	MEO	LOW	SPECIAL VEHICLES TRUCKS	COMMR AUTOS	TAXIS	UNADJ WORK ATTRS	UNADJ OTHER ATTRS
1							13	11		341	3680
2		22	22				6	6		53	663
3		11	21			11	8	5		263	2748
4		53	32	21						53	150
5	4	25	2	12	5						108
6		53	26	105	53					30	594
7	53	79	26	26				5		210	1814
8		53					21			105	886
9	26	95	11	79	26		8			226	1517
10		26	11	32	5		21	16		499	1808
11	5	37		9	2		13			214	2291
12		53	3	32	13					79	500
13				26	11					26	369
14				28	16					53	465
15		5		26	2		78			68	248
16				18	24			11		341	1426
17							15	26		2100	5347
18		5		13	13		8			420	1615
19	265	210					4			184	2000
20		79		26			11			134	771
21		74		21						53	266
22	126	53		26	32		6				270
23		37	21				15	11		152	1022
24										29	632
25	11	42		11	11					56	1194
26		29								51	560
27	10	32					2			63	807
28	11	38	4					5		142	875
29		11		11						137	1600
30		21	5				9			131	647
31		16	8				4			58	676
32		26	11	16	10					5	161
33	11	68		26	11						160
34		11		9	2						74
35		12		10							74
TOTAL	522	203		589			242	96		6276	37818
	1276			26	215						

BASIC INTERNAL DATA / TRIPS BY UNIT
APEX 2005 DATA
12/15/81 P56504

ZONE	TRIPS BY DWELLING UNITS WHITE HGH	MEO	LOW	NON-WHITE HGH	MEO	LOW	AUTO TRIPS	TRUCK TRIPS	COMMR AUTO TRIPS	TAXI TRIPS	TOTAL TRIPS
1								67	74		161
2		132	70				202	40	40		282
3		66	67			35	168	54	34		256
4		318	102	126			546				546
5	35	150	6	72	16		279				279
6		318	83	630	170		1201				1201
7	466	474	83	156			1179		34		1213
8		318					318	141			459
9	229	570	35	474	83		1391	54			1445
10		156	35	192	16		399	141	107		647
11	44	222		54	6		326	87			413
12		318	10	192	42		562				562
13				156	35		191				191
14				168	51		219				219
15		30		156	6		192	523			715
16				108	77		185		74		259
17								101	174		275
18		30		78	42		150	54			204
19	2332	1260					3592	27			3619
20		474		156			630	74			704
21		444		126			570				570
22	1109	318		229	192		1848	40			1888
23		222	67				289	101	74		464
24											
25	97	252			66	35	450				450
26		174					174				174
27	88	192					280	13			293
28	97	228	13				338		34		372
29		66		66			132				132
30		126	16				142	60			202
31		96	26				122	27			149
32		156	35	96	32		319				319
33	97	408		156	35		696				696
34		66		56	6		126				126
35		72		60			132				132
TOTAL	12898			4450			17348	1624	645		19617

	HIGH	MEDIUM	LOW
AUTO TRIPS / D.U.			
WHITE	8.8	6.0	3.2
NON-WHITE	8.8	6.0	3.2
TRUCK TRIPS / TRUCK		6.7	
COMMERCIAL AUTO TRIPS / COMMERCIAL AUTO		6.7	
TAXI TRIPS / TAXI		40.0	

BASIC INTERNAL DATA / TRIPS BY PURPOSE
APEX 2005 DATA
12/15/81 P56504

ZONE	INTRL TRIPS	HOME WORK TRIPS	OTHER HOME TRIPS	NON HOME INTRL	NON HOME EXTRL	ADJST WORK ATTRS	ADJST OTHER ATTRS	ADJST NON-H ATTRS
1	98	23	53	23		150	626	534
2	172	40	93	40		23	113	56
3	156	36	84	36		115	467	398
4	333	77	180	77		23	26	22
5	170	39	92	39			18	16
6	733	169	396	169		13	101	86
7	740	170	400	170		92	308	263
8	280	64	151	64		46	151	128
9	881	203	476	203		99	258	220
10	395	91	213	91		219	307	262
11	252	58	136	58		94	389	332
12	343	79	185	79		35	85	73
13	117	27	63	27		11	63	54
14	134	31	72	31		23	79	67
15	436	100	235	100		30	42	36
16	158	36	85	36		150	242	207
17	168	39	91	39		922	909	775
18	124	29	67	29		184	275	234
19	2208	508	1192	508		81	340	290
20	429	99	232	99		59	131	112
21	348	80	188	80		23	45	39
22	1152	265	622	265			46	39
23	283	65	153	65		67	174	148
24						13	73	63
25	275	63	149	63		25	203	173
26	106	24	57	24		22	95	81
27	179	41	97	41		28	137	117
28	227	52	123	52		62	149	127
29	81	19	44	19		60	272	232
30	123	28	66	28		58	110	94
31	91	21	49	21		25	115	98
32	195	45	105	45		2	27	23
33	425	98	230	98			27	23
34	77	18	42	18			13	11
35	81	19	44	19			13	11
TOTAL	11970	2756	6465	2756	2738	2754	6429	5484

TRIP PERCENTAGE	
INTERNAL OF TOTAL	61
HOME BASED WORK OF INTERNAL	23
OTHER HOME BASED OF INTERNAL	54
NON HOME BASED OF INTERNAL	23

APPENDIX A, TABLE 24

ZONE DWELLING UNIT, POPULATION AND TAXI DATA

APPENDIX B

THOROUGHFARE PLAN STREET TABULATION AND RECOMMENDATIONS

FACILITY & SECTION	EXISTING X - SECTION DIST MI	RDWY FT	ROW FT	CAPACITY CURRENT (FUTURE)	1978 ADTS	1995 ADTS	RECOMMENDED X - SECTION ROW (ULT)	RDWAY (ULT)
APEX MACEDONIA RD								
US 1/64 - HOLLY SPRINGS	3.21	20	60	5200	3400	6800	90	64
NC 54 - HIGHHOUSE RD	1.55					8000	106	2/26
HIGHHOUSE RD - CHATHAM AVE	1.52					8000	106	2/26
CHATHAM ST - LAKE PINE RD	.76					8000	106	2/26
LAKE PINE RD - KILDA FARM	1.48					10000	106	2/26
KILDAIRE FARM RD - US 1 S	.97					10000	106	2/26
US 1 S - HOLLY SPRINGS RD	2.27					10000	106	2/26
CHAPEL HILL RD (NC 54)								
CARY PARKWAY - MAYNARD RD	1.25	22	60	5200	4400	8000	90	64
MAYNARD RD - HARRISON AVE	.89	22	60	5200	5500	8200	78	64
HARRISON AVE - ACADEMY ST	.11	22	60	5200	7200	9200	78	64
ACADEMY ST - WALKER ST	.28	24	150	8000	7200	9200	90	64
WALKER ST - MAYNARD RD	.71	24	100	8000	4100	8500	90	64
MAYNARD RD - BELTLINE	.31	24	100	8000	4100	8500	90	64
CHATHAM ST/HILLSBOROUGH RD								
CARY PARKWAY - MAYNARD RD	1.37	22	60	5200	4000	7200	90	64
MAYNARD RD - HIGHHOUSE RD	.95	22	60	5200	4000	7200	90	64
HIGHHOUSE RD - HARRISON AV	.38	22	60	5200	4000	7200	78	52
HARRISON AVE - ACADEMY ST	.14	32	60	8000	10000	12500	78	52
ACADEMY ST - WALKER ST	.13	32	50	8000	9500	12500	78	52
WALKER ST - URBAN DR	.27	32	60	8000	9500	12500	78	52
URBAN DR - US 70A	.18	30	100	8000	9500	12500	78	52
US 70A - MAYNARD RD	.45	30	60	8000	13700	17000	78	52
MAYNARD RD - BELTLINE	.91	20	60	5200	15000	18000	78	52
EVANS RD (SR 1653) & EXTEN								
N MAYNARD RD - CARY PARKWA	1.70					3600	70	34
HARRISON AVE/KILDAIRE FARM								
I 40 - MAYNARD RD EXT	2.46	24	80	8000		9600	ADQ	52
MAYNARD RD EXT - NC 54	.72	24	80	8000		9600	ADQ	52
NC 54 - CHATHAM ST	.30	18	60	4800	4800	9600	78	52
CHATHAM ST - SCHOOL ST	.23	36	60	9600	4000	9200	78	52
SCHOOL ST - KILDAIRE FARM	.20					9200	78	52
DOWELL DR - MAYNARD RD	.57	18	60	4800	7200	8500	90	64
MAYNARD RD - US 1 & 64	1.89	18	60	4800	6700	8000	90	64
US 1 & 64 - PENNY RD	2.10	18	60	4800	3600	6000	90	64
HI HOUSE EXT/CHATHAM ST								
HI HOUSE RD - CHATHAM ST	.34					6000	90	64
HI HOUSE RD(SR 1616)APEX RD								
CARY PARKWAY - MAYNARD RD	1.19	18	60	4800	3200	5600	90	64
MAYNARD RD - OLD APEX RD	.36	18	60	4800	3200	5600	90	64
OLD APEX RD - CHATHAM ST	.38	18	60	4800	3500	5500	90	64

APPENDIX 8
THOROUGHFARE PLAN STREET TABULATION AND RECOMMENDATIONS
CONTINUED

FACILITY & SECTION	EXISTING X - SECTION DIST MI	RDWY FT	ROW FT	CAPACITY CURRENT (FUTURE)	1978 ADTS	1995 ADTS	RECOMMENDED X - SECTION ROW (ULT)	RDWAY (ULT)
MAYNARD ROAD								
CHAPEL HILL RD - HI HOUSE	1.21					6200	90	64
HI HOUSE - SR 1011(OLD 64)	.61					6200	90	64
SR 1011 - KILDAIRE FARM RD	1.06	24	80	8000	10600	12500	90	64
KILDAIRE FARM RD - WALNUT	1.02	24	80	8000	12000	18000	90	64
WALNUT ST - HILLSBOROUGH	1.33	20	60	5200	10000	12500	90	64
HILLSBOROUGH RD - REEDY CR	.57					6000	90	64
REEDY CREEK RD - NC 54	1.59					6000	90	64
PLANTATION DRIVE & EXT/ LAKE PINE DRIVE								
S MAYNARD RD - BROOKGREEN	.17					4000	70	44
BROOKGREEN - LAKEPINE DR	.76					4000	70	44
LAKEPINE - CARY PARKW	.45					4000	70	44
CARY PARKWAY - US 64 WEST	1.33					4000	70	44
REEDY CREEK RD (SR 1650)								
HILLSBOROUGH RD - NC 54	.19	18	60	4800	2200	5200	70	44
NC 54 - MAYNARD RD	.61	18	60	4800	1600	5200	70	44
MAYNARD RD - N HARRISON ST	1.00	18	60	4800	1600	5200	70	44
SEABROOK AVE & EXTENSION								
SOUTH MAYNARD - CARY PARKW	1.10					2400	60	34
SR 1319 (JONES-FRANKLIN)								
BELTLINE TO SR 1152	2.10		60		5300	7200	90	64
TRINITY ROAD & EXTENSION								
HARRISON AVE - TRINITY RD	1.89					8500	106	2/26
TRINITY RD - I 40	.38	24	80	8000	1500	10000	106	2/26
TRINITY ROAD (SR 1655)								
HILLSBOROUGH RD - NC 54	.34	18	60	4800	1600	5200	78	52
NC 54 - ARRINGTON RD	.93	18	60	4800	2700	5200	78	52
ARRINGTON RD - I 40	.83	18	60	4800	2200	5200	78	52
US 70A								
CHAPEL HILL RD - CHATHAM	.38	22	60	5200	3000	7200	ADQ	24
US 1 SOUTH								
SOUTHERN BELTLOOP - CORDON	4.55	2/24	260	38000	14500	30000	ADQ	ADQ
US 64 WEST/ CORDON - US 1 S								
CORDON LINE - UNION ST	.19	24	180	8000	7200	10000	ADQ	2/24
UNION STREET - US 1 SOUTH	.66	24	180	8000	7200	10000	ADQ	2/24

APPENDIX B
THOROUGHFARE PLAN STREET TABULATION AND RECOMMENDATIONS
CONTINUED

FACILITY & SECTION	EXISTING X - SECTION DIST MI	RDWY FT	ROW FT	CAPACITY CURRENT (FUTURE)	1978 ADTS	1995 ADTS	RECOMMENDED X - SECTION ROW (ULT)	RDWAY (ULT)
WALKER STREET								
CHAPEL HILL RD - NEW LOCAT	.05	22	40	5200		7200	78	52
NEW LOCATION - US 70 A	.05					7200	78	52
US 70A - AMBASSADOR ST	.16	22	40	5200		7200	78	52
AMBASSADOR ST - CEDAR ST	.05					7200	78	52
CEDAR ST - CHATHAM ST	.06	22	35			7200	78	52
CHATHAM ST - NEW LOCATION	.32	22	35			7200	78	52
NEW LOCATION - WALNUT ST	.04					7200	78	52
WALNUT STREET								
KILDAIRE FARM RD - WALKER	.27	22	40	5200	6100	9200	78	52
WALKER ST - RALPH DRIVE	.29	26	60	6000	6300	9200	90	52
RALPH DRIVE - MAYNARD RD	1.02	20	60	5200	8300	12000	90	64
MAYNARD RD - BELTLINE	1.33	20	60	5200	15200	22000	90	64
BELTLINE - SR 1319							90	64
WESTERN BLVD CONNECTOR TO WALNUT STREET								
WESTERN BLVD EXT-WALNUT ST	.57					14000	80	52
WESTERN BOULEVARD								
WALNUT ST - MAYNARD RD	.25	64	90			12000	ADQ	64
MAYNARD RD - SOUTH BELTLIN	.83					14000	90	64

APPENDIX C

RECOMMENDED DEFINITIONS AND DESIGN STANDARDS FOR SUBDIVISION ORDINANCES

DEFINITIONS:

I. Streets and Roads:

A. Rural Roads

1. Principal Arterial - A rural link in a network of continuous routes serving corridor movements having trip length and travel density characteristics indicative of substantial statewide or interstate travel and existing solely to serve traffic. This network would consist of Interstate routes and other routes designated as principal arterials.

2. Minor Arterial - A rural link in a network joining cities and larger towns and providing intrastate and intercounty service at relatively high overall travel speeds with minimum interference to through movement. This network would primarily serve traffic.

3. Major Collector - A road which serves major intracounty travel corridors and traffic generators and provides access to the Arterial system.

4. Minor Collector - A road which provides service to small local communities and links the locally important traffic generators with their rural hinterland.

5. Local Road - A local road that serves primarily to provide access to adjacent land and for travel over relatively short distances.

B. Urban Streets

1. Major Thoroughfares - Major thoroughfares consist of Interstate, other freeway, expressway, or parkway links, and major streets that provide for the expeditious movement of high volumes of traffic within and through urban areas.

2. Minor Thoroughfares - Minor thoroughfares are important streets in the city system and perform the function of collecting traffic from local access streets and carrying it to the Major Thoroughfare system. Minor thoroughfares may be used to supplement the Major Thoroughfare system by facilitating a minor through-traffic movement and may also serve abutting property.

3. Local Street - A local street is any link not on a higher-order urban system and serves primarily to provide direct access to abutting land and access to higher systems.

C. Specific Type Rural or Urban Streets

1. Freeway, expressway, or parkway - Divided multilane roadways designed to carry large volumes of traffic at relatively high speeds. A freeway is a divided highway providing for continuous flow of vehicles with no direct access to abutting property or streets and with access to selected crossroads provided via connecting ramps. An expressway is a divided highway with full or partial control of access and generally with grade separations at major intersections. A parkway is a highway for noncommercial traffic, with full or partial control of access, and usually located within a park or a ribbon of parklike development.

2. Residential Collector Street - A local access street which serves as a connector street between local residential streets and the thoroughfare system. Residential collector streets typically collect traffic from 100 to 400 dwelling units.

3. Local Residential Street - Cul-de-sacs, loop streets less than 2,500 feet in length, or streets less than one mile in length that do not connect thoroughfares, or serve major traffic generators, and do not collect traffic from more than 100 dwelling units.

4. Cul-de-sac - A short street having but one end open to traffic and the other end being permanently terminated and a vehicular turn around provided.

5. Frontage Road - A local street or road that is parallel to a full or partial access controlled facility and functions to provide access to adjacent land.

6. Alley - A strip of land, owned publicly or privately, set aside primarily for vehicular service access to the back side of properties otherwise abutting on a street.

II. Property

A. Building Setback Line - A line parallel to the street in front of which no structure shall be erected.

B. Easement - A grant by the property owner for use by the public, a corporation, or person(s), of a strip of land for a specific purpose.

C. Lot - A portion of a subdivision, or any other parcel of land, intended as a unit for transfer of ownership or for development or both. The word "lot" includes the words "plat" and "parcel".

1. Corner Lot - A lot abutting upon two streets at their intersection.

2. Double-Frontage Lot - A continuous (through) lot which is accessible from both of the parallel streets upon which it fronts.

3. Reverse-Frontage Lot - A continuous (through) lot which is accessible from only one of the parallel streets upon which it fronts.

III. Subdivision

A. Subdivider - Any person, firm, corporation or official agent thereof, who subdivides or develops any land deemed to be a subdivision.

B. Subdivision - All divisions of a tract or parcel of land into two or more lots, building sites, or other divisions for the purpose, whether immediate or future, of sale or building development, and all divisions of land involving the dedication of a new street or a change in existing streets; provided, however, that the following shall not be included within this definition nor subject to these regulations: (1) the combination or recombination of portions of previously platted lots where the total number of lots is not increased

and the resultant lots are equal to or exceed the standards contained herein; (2) the division of land into parcels greater than five acres where no street right-of way dedication is involved; (3) the public acquisition by purchase of strips of land for the widening or opening of streets; (4) the division of a tract in single ownership whose entire area is no greater than two acres into not more than three lots, where no street right-of-way dedication is involved and where the resultant lots are equal to or exceed the standards contained herein.

C. Dedication - A gift, by the owner, of his property to another party without any consideration being given for the transfer. Since a transfer of property is involved, the dedication is made by written instrument and is completed with an acceptance.

D. Reservation - A reservation of land does not involve any transfer of property rights. It simply constitutes an obligation to keep property free from development for a stated period of time.

Design Standards

I. Streets and Roads:

The design of all streets and roads within Apex shall be in accordance with the accepted policies of the North Carolina Department of Transportation, Division of Highways, as taken or modified from the American Association of State Highway Officials' (AASHO) manuals.

The provision of street rights-of-way shall conform and meet the requirements of the thoroughfare plan for the Town of Apex as approved by the Planning and Research Branch and adopted by the local bodies and the North Carolina Board of Transportation.

The proposed street layout shall be coordinated with the existing street system of the surrounding area. Normally the proposed streets should be the extension of existing streets if possible.

The urban planning area shall consist of that area within the urban planning boundary as depicted on the mutually adopted Apex Thoroughfare Plan.

The rural planning area shall be that area outside the urban planning boundary.

A. Right-of-Way Widths: Right-of-way widths shall not be less than the following and shall apply except in those cases where right-of-way requirements have been specifically set out in the Apex Thoroughfare Plan.

		Min. Right of Way, Ft.
1.	Rural	
	a. Principal Arterial	
	Freeways	350
	Other	200
	b. Minor Arterial	100
	c. Major Collector	100
	d. Minor Collector	100
	e. Local Road	*60

*The desirable minimum right-of-way is 60 feet. If curb and gutter is provided, 50 feet of right-of-way is adequate on local residential streets.

		Min. Right of Way, Ft.
2.	Urban	
	a. Major Thoroughfare Other than Freeway and Expressway	90
	b. Minor Thoroughfare	70
	c. Local Street	*60
	d. Cul-de-sac	**Variable

The subdivider will only be required to dedicate a maximum of 100 feet of right-of-way. In cases where over 100 feet of right-of-way is desired, the subdivider will be required only to reserve the amount in excess of 100 feet. In all cases in which right-of-way is sought for an access controlled facility, the subdivider will only be required to make a reservation.

A partial width right-of-way, not less than sixty (60) feet in width, may be dedicated when adjoining undeveloped property that is owned or controlled by the subdivider; provided that the width of a partial dedication be such as to permit the installation of such facilities as may be necessary to serve abutting lots. When the said adjoining property is subdivided, the remainder of the full required right-of-way shall be dedicated.

B. Street Widths: Widths for street and road classifications other than local shall be as required by the Thoroughfare Plan. Width of local roads and streets shall be as follows:

a. Local Residential
Curb and gutter section 26 feet, to face of curb
Shoulder section - 20 feet to edge of pavement, 4 foot shoulders

---

*The desirable minimum right-of-way is established as 60 feet. If curb and gutter is provided, 50 feet of right-of-way is adequate.

**The right-of-way dimension will depend on radius used for vehicular turn-around. Distance from edge of pavement of turn around to right-of-way should not be less than distance from edge of pavement to right-of-way on street approaching turn-around.

b. Residential Collector

Curb and gutter section 34 feet, face to face of curb

Shoulder Section 20 feet to edge of pavement, 6 foot shoulders

C. Geometric Characteristics: The standards outlined below shall apply to all subdivision streets proposed for addition to the State Highway System or Municipal Street System. In cases where a subdivision is sought adjacent to a proposed thoroughfare corridor, the requirements of dedication and reservation discussed under Right-of-Way shall apply.

1. Design Speed

The design speeds for subdivisions type streets shall be:

	Desirable	(Minimum)		
		Level	Rolling	Mountainous
Rural				
Minor Collector Roads	60	(50)	(40)	(30)
Local Roads including Residential Collectors and Local Residential	50	(50)*	(40)*	(30)*
Urban				
Major Thoroughfares Other than Freeway or Expressway	60	(50)	(50)	(50)
Minor Thoroughfares	60	(50)	(40)	(40)
Local Streets	40	(40)**	(30)**	(20)**

---

*Based on projected annual average daily traffic of 400-750. In cases where road will serve a very limited area and small number of dwelling units, minimum design speeds can be reduced further.

**Based on projected annual average daily traffic of 50-250.

2. Maximum and Minimum Grades

a. The maximum grades in percent shall be:

Design Speed	Level	Rolling	Mountainous
60	3	4	6
50	4	5	7
40	5	6	8
30		9	10
20			12

b. A minimum grade for curbed streets normally should not be less than 0.5%, a grade of 0.35% may be allowed where there is a high type pavement accurately crowned and in areas where special drainage conditions may control.

c. Grades for 100 feet each way from intersections should not exceed 5%.

d. For streets and roads with projected annual average daily traffic less than 250, short grades less than 500 feet long, may be 150% greater.

3. Minimum Sight Distances

In the interest of public safety, no less than the minimum sight distance applicable shall be provided in every instance. Vertical curves that connect each change in grade shall be provided and calculated using the following parameters. (General practice calls for vertical curves to be multiples of 50 feet. Calculated lengths shall be rounded up in each case):

DESIGN SPEED, MPH	20	30	40	50	60
Stopping Sight Distance -					
i. Min. Stopping Distance, Ft.	150	200	275	350	475
Des. Stopping Distance, Ft.	150	200	300	450	650
ii. Min. K* Value For:					
a. Min. Crest Vert. Curve	16	28	55	85	160
Des. Crest Vert. Curve	16	28	65	145	300
b. Min. SAG Vert. Curve	24	35	55	75	105
Des. SAG Vert. Curve	24	35	60	100	155
Passing Sight Distance -					
i. Min. Passing Distance, Feet (2 lane)		1100	1500	1800	2100
ii. Min. K* Value For Crest Vertical Curve		365	686	985	1340

Sight distance provided for stopped vehicles at intersections should be in accordance with, "A Policy on Geometric Design of Rural Highways".

4. The following table shows the maximum degree of curve and related maximum superelevation for design speeds. The maximum rate of roadway superelevation (e) for rural roads wth no curb and gutter is .08. The maximum rate of superelevation for urban streets with curb and gutter is .06 with .04 being desirable.

---

*K is a coefficient by which the algebraic difference in grade may be multiplied to determine the length in feet of the vertical curve which will provide minimum sight distance.

Design Speed MPH	Maximum e*	Minimum Radius (Rounded) Feet	Maximum Degree of Curve (Rounded) Degrees
20	.04	125	45.0
30	.04	300	19.0
40	.04	560	10.0
50	.04	925	6.0
60	.04	1410	4.0
20	.06	115	50.0
30	.06	275	21.0
40	.06	510	11.5
50	.06	830	7.0
60	.06	1260	4.5
20	.08	110	53.5
30	.08	250	23.0
40	.08	460	12.5
50	.08	760	7.5
60	.08	1140	5.0

*e = rate of roadway superelevation, foot per foot

D. Intersections

1. Streets shall be laid out so as to intersect as nearly as possible at right angles, and no street should intersect any other street at an angle less than sixty (60) degrees.

2. Property lines at intersections should be set so that the distance from the edge of pavement, of the street turnout, to the property line will be at least as great as the distance from the edge of pavement to the property line along the intersecting streets. This property line can be established as a radius or as a sight triangle. Greater offsets from the edge of pavement to the property lines will be required, if necessary, to provide sight distance for the stopped vehicle on the side street.

3. Off-set intersections are to be avoided unless exception is granted by the Divison of Highways. Intersections which cannot be aligned should be separated by a minimum length of 200 feet between survey centerlines.

E. Cul-de-sacs

Cul-de-sacs, unless exception is granted by the local planning board, shall not be more than five hundred (500) feet in length. The distance from the edge of pavement on the vehicular turnaround to the right-of-way line should not be less than the distance from the edge of pavement to right-of-way line on the street approaching the turn-around. Cul-de-sacs should not be used to avoid connection with an existing street or to avoid the extension of an important street.

F. Alleys

1. Alleys shall be required to serve lots used for commercial and industrial purposes except that this requirement may be waived where other definite and assured provision is made for service access.

   Alleys shall not be provided in residential subdivisions unless necessitated by unusual circumstances.

2. The width of an alley shall be at least twenty (20) feet.

3. Dead-end alleys shall be avoided where possible, but if unavoidable, shall be provided with adequate turn-around facilities at the dead-end as may be approved by the Planning Board.

4. Sharp changes in alignment and grade shall be avoided.

G. Permits For Connection To State Roads

An approved permit is required for connection to any existing state system road. This permit is required prior to any construction on the street or road. The application is available at the office of the nearest District Engineer of the Divison of Highways.

H. Offsets To Utility Poles

Poles for overhead utilities should be located clear of roadway shoulders, preferably a minimum of at least 30 feet from the edge of pavement. On streets with curb and gutter, utility poles shall be set back a minimum distance of 6 feet from the face of curb.

I. Wheel Chair Ramps

In accordance with Chapter 136, Article 2A, 13644.14, all street curbs in North Carolina being constructed or reconstructed for maintenance procedures, traffic operations, repairs, correction of utilities, or altered for any reason after September 1, 1973, shall provide wheelchair ramps for the physically handicapped at all intersections where both curb and gutter and sidewalks are provided and at other major points of pedestrian flow.

Wheelchair ramps and depressed curbs shall be constructed in accordance with details contained in the Department of Transportation, Divison of Highways, Publication entitled, "Guidelines, Curb Cuts and Ramps for Handicapped Persons".

J. Horizontal Width on Bridge Deck

1. The clear roadway widths for new and reconstructed bridges serving 2 lane, 2-way traffic should be as follows:

a. Shoulder Section Approach

i. Under 800 ADT Design Year
Minimum 28 feet width face to face of parapets of rails or pavement width plus 10 feet, whichever is greater.

ii. 800-2000 ADT Design Year
Minimum 34 feet width face to face of parapets or rails or pavement width plus 12 feet, whichever is greater.

iii. Over 2000 ADT Design Year
Minimum 40 feet
Desirable 44 feet width face to face of parapets or rails.

b. Curbs and Gutter Approach

i. Under 800 ADT Design Year
Minimum 24 feet face to face of curbs.

ii. Over 800 ADT Design Year
Width of approach pavement measured face to face of curbs.

Where curb and gutter sections are used on roadway approaches, curbs on bridges shall match the curbs on approaches in height, in width of face to face of curbs, and in crown drop. The distance from face of curb to face of parapet or rail shall be 1'6" minimum, or greater if sidewalks are required.

2. The clear roadway widths for new and reconstructed bridges having 4 or more lanes serving undivided two-way traffic should be as follows:

   a. Shoulder Section Approach - Width of approach pavement plus width of usable shoulders on the approach left and right.
      Min. 8'
      Des. 10'

   b. Curb and Gutter Approach Width of approach pavement measured face to face of curbs.

STATE LIBRARY OF NORTH CAROLINA
3 3091 00748 3365

the
good
roads
state